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THE REMEDIES OF NATURE.

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CONSUMPTION.

THE organism of the human body is a self-regulating apparatus. Every interruption of its normal functions excites a reaction against the disturbing cause. If a grain of caustic potash irritates the nerves of the palate, the salivary glands try to remove it by an increased secretion. The eye would wash it off by an immediate flow of tears. A larger quantity of the same substance could be swallowed only under the protest of the fauces, and the digestive organs would soon find means to eject it. The bronchial tubes promptly react against the obtrusion of foreign substances. The sting of an insect causes an involuntary twitching of the epidermis. If a thorn or splinter fastens itself under the skin, suppuration prepares the way for its removal. If the stomach be overloaded with food, it revolts against further ingestion.

These automatic agencies of the organism generally suffice to counteract the disturbing cause, and the sensory symptoms attending the process of reconstruction constitute merely a plea for non-interference. The suppurating tissues push the thorn outward, and resent only a pressure in the opposite direction. The eye volunteers to rid itself of the sand-dust, but remonstrates against friction. The rum-soaked system of the toper undertakes to eliminate the poison, and only asks that the consequences of the outrage be not aggravated by its repetition. But, if that plea remains unheeded, it finally takes the form of the emphatic protest we call *disease*. For, even in its urgent manifestations, the reaction against a violation of Nature's health-laws is a cry for peace, rather than a petition for active assistance in the form of medication. "Accustom yourself in all your little pains and aches,"

says Dr. Jennings, "and also in your grave and more distressing affections, to regard the movement concerned in them in a friendly aspect —designed for and tending to the removal of a difficulty of whose existence you were before unaware, and which, if suffered to remain and accumulate, might prove the destruction of the house you live in —and that, instead of its needing to be 'cured,' it is itself a curative operation; and that what should be called *disease* lies back of the symptoms which, in fact, are made for the express purpose of removing the real disorder or difficulty" ("Medical Reform," p. 310).

Drugs can rarely do more than change the form of the disease, or postpone its crisis. Mercurial salve, which conscientious physicians have almost ceased to regard as a lesser evil of any alternative, was once a favorite prescription for all kinds of cutaneous diseases: it cleansed the skin by driving the ulcers from the surface to the interior of the body. A drastic purge counteracts constipation—for a day or two—by inducing a still less desirable state of artificial dysentery. Combined with venesection the same "remedy" will suppress the symptoms of various inflammatory affections by compelling the exhausted system to postpone the crisis of the disease; in other words, by interrupting a curative process. The best way to "assist" Nature in such cases is to give her fair play by forbearing to meddle with her restorative methods, and by removing the predisposing cause of the disorder. Diseases plead for *desistance*, rather than for assistance, and the discovery of the cause is the discovery of the remedy. For there is a strong upward and healthward tendency in the constitution of every living organism: Nature's revenge is but an enforced condition of peace. *Pain, discomfort, and even the premature loss of organic vigor, are the attendant symptoms of a reconstructive process, and their permanence is a presumptive proof that, in spite of such admonitions, that process is a struggle against a permanent obstacle, or against a constantly repeated frustration of its efforts.*

To this self-regulating tendency of the living organism, certain disorders (the *lues veneris*, prurigo, etc.)—probably due to the agency of microscopic parasites—oppose a life-energy of their own, and have thus far resisted the influence of hygienic or non-medicinal remedies. But, with that exception, it may be laid down as a general rule that the virulence and duration of every disease are proportioned to the degree and the *contumacy* of the provocation—a retribution proportioned to the degree of the guilt, we should say, if Nature did not administer her code after the principle that ignorance of the law constitutes no excuse. The ignorant mother who, with the best intentions in the world, forces her child to sleep in an air-tight bedroom, incurs the penalties of an inexorable law as surely as the vicious father who tempts his child to a life of infamy.

In the aggregate, hygienic errors cause more mischief than hygienic recklessness; and, if we would know the most baneful of those errors,

we must inquire after the cause of the most fatal disease. The alcohol-habit slays its thousands every year; but statistics prove that human life has a more terrible foe. The proportion of deaths from all diseases that can be ascribed to the effects of intemperance relates as three and a half to ten in Northern Europe, and as four to ten in the United States and Canada—to the mortality-rate of PULMONARY CONSUMPTION. Without counting acute pneumonia and other fatal lung-diseases, tubercular phthisis alone claims yearly one life out of 410 to 415; or an aggregate which, for the United States, has been estimated at 94,000; in Great Britain and Ireland, 110,000 (or one of every 300 inhabitants); in France, 80,000; in European Russia, 105,000; in Northern Germany (including the Polish provinces of Prussia), 82,000. And the quantum of the mischief is still aggravated by its quality. Consumption fulfills no scavenger's mission: the most voracious is, withal, the most fastidious disease, and selects its victims from the most industrious classes of the noblest nations; hard-working mechanics, devoted supporters of large families, bread-winning laborers and prize-winning students are its favorite victims. For the last fifty years its ravages have steadily increased; but the excess of the evil has finally revealed the means of deliverance, and the worst scourge of the human race has one redeeming feature: that its cause, and consequently its proper cure, have at last been determined with absolute certainty. Not more than fifty years ago the consumption-problem was still the *crux medicorum;* the disease seemed almost unaccountable and wholly incurable. Practical physicians had ascertained the value of certain secondary remedies, the prophylactic influence of fat and phosphates (cod-liver oil, etc.), and of chest-expanding gymnastics; but they had failed to recognize the great specific. Misled by the most prevalent of all popular delusions—the Cold-Air Fallacy*—they ascribed consumption to the influence of a low temperature, and tried to cure it by sending their wealthier patients to a warmer climate and the poorer to an air-tight sick-room. There were hospitals for consumptives where invalids were nursed with a care that would have insured recovery from almost every other disease, but here all calculations were defeated by the result of one wrong factor; the chief efficacy of the treatment was supposed to depend upon the exclusion of every draught of fresh air.

But statistics have at last exploded that delusion. It was ascertained that consumption is essentially a *house-disease.* North or south,

* "Dry and intensely cold air preserves decaying organic tissues by arresting decomposition, and it would be difficult to explain how the most effective remedy came to be suspected of being the cause of tuberculosis, unless we remember that, where fuel is accessible, the disciples of civilization rarely fail to take refuge from excessive cold in its opposite extreme—an overheated, artificial atmosphere, and thus come to connect severe winters with the idea of pectoral complaints. . . . They avoid cold instead of impurity, just as tipplers, on a warm day, imagine that they would 'catch their death' by a draught from a cool fountain, but never hesitate to swallow the monstrous mixtures of the liquor-venders" ("Physical Education," p. 80; compare pp. 85, 98, and 248).

east or west, the death-rate from lung-diseases was found to bear an exact proportion to the percentage of the inhabitants habitually engaged in sedentary and in-door occupations. Towns suffer more than the rural districts, cities more than country towns, manufacturing cities more than commercial and semi-agricultural cities, weaver-towns more than foundry-towns. "If a perfectly sound man is imprisoned for life," says Baron d'Arblay, the Belgian philanthropist, "his lungs, as a rule, will first show symptoms of disease, and shorten his misery by a hectic decline, unless he should commit suicide."

Moreover, it was shown that in non-manufacturing (uncivilized or pastoral) regions a low temperature seems to afford a protection against pulmonary disorders. Professor Jacoud found that, at an elevation of four thousand feet, the cold Alpine districts of Northern Savoy are almost free from lung-diseases. The medical statistics of the Austrian army have established the fact that recruits from the Tyrol, from Carinthia, and the Carpathians (Transylvania), i. e., from the highest, and consequently the coldest, provinces of the empire, enjoy a remarkable immunity from tubercular consumption. Dr. Hjaltelin, a resident of Iceland, states that among the inhabitants of that country pulmonary diseases are almost unknown.

But in the temperate zone consumption-statistics alone would enable us to infer the amount of dust-breathing and in-door work incidental to the pursuit of each trade. In the Italian cities that have largely engaged in the production of textile fabrics, consumption has become as frequent as in Lancashire. Irrespective of race-differences and special dietetic habits, the habitual breathing of vitiated air leads to the development of pulmonary scrofula. And science has furnished the *rationale* of that result. Physiology has demonstrated that air is gaseous food, and respiration a process of digestion. The atmosphere furnishes the raw material of the pulmonary pabulum; at each inspiration the organism of the lungs imbibes the oxygenous or nutritive principle of the air-draught, and excretes the indigestible elements. By breathing the same air over and over again, the atmospheric aliment becomes azotized, i. e., depleted of its life-sustaining principle, and therefore unfit to supply the wants of the animal economy. The continued inhalation of such vitiated air fills the respiratory organs with indigestible elements, which gradually accumulate beyond the dislodging ability of the vital forces, and at last corrupt the tissue of the congested organ and favor the development of parasites. Consumption is one of the diseases that seem to confirm the tenets of the germ-theory. A tubercular diathesis is favored by stagnant impurities of the circulatory system, by a warm and humid climate, and counteracted by cold air and other antiseptics. Six years ago a German physician demonstrated that the progress of pulmonary scrofula can be arrested by a pectoral injection of carbolic acid; and one of his countrymen lately ascertained that the tubercle-virus is alive with micro-

scopic parasites, that multiply like the spores of a prolific mushroom. The first development of these lung-devourers would seem to amount to a sentence of speedy death; yet their fecundity hardly exceeds that of certain intestinal parasites, and the *vis vitæ* has methods of her own for dealing with such foes, and is ever ready to begin the battle for life, on the sole condition that we do not complicate the difficulties of the undertaking by counteracting her efforts or by perpetuating the influence of the original cause. Cease to feed the lungs with azotic gases, and Dr. Koch's animalcula will starve and disappear as surely as maw-worms will starve and disappear if we change a pork and sourcrout diet for bread and apples.

About the comparative advantages of a dry and cold or moist and tropical climate, opinions are divided, with a preponderance of arguments in favor of the former; but so much is certain, that in all latitudes of the temperate zone the disease known as pulmonary consumption is caused by the breathing of vitiated air and can be *subdued* by out-door exercise. In certain cases *cured* would be an ambiguous term. The respiration of vitiated (azotized and dust-impregnated) air results in the corruption of the pulmonary tissues, and finally in a process of disintegration that fills the structure of the lungs with ulcerous cavities. These cavities often cicatrize, but it is not probable that they can be entirely healed, i. e., that the wasted tissues can be reproduced. Yet in all but its last stages the *progress* of the disease can be arrested by out-door life alone. The voice of instinct adds its testimony to the teaching of science. In the language of our senses, every feeling of discomfort suggests its own remedy. If the proximity of a glowing stove begins to roast your shins, the alarmed nerves cry out—not for patent ointments, not for anti-caustic liniments and "pain-killers," but for a lower temperature. Nothing else will permanently appease them. Millions of prisoners, school-children, and factory-slaves, pine for lung-food as a starving man yearns for bread; and that hunger can not be stilled with cough-pills, but only with fresh air.

There are adjuvant remedies which will be noticed hereafter, but their co-operation is not indispensable. Without a sufficient supply of wholesome food, without warm clothes, without domestic comforts, under the disadvantage even of excessive hardships and protracted fasts, a three months' mountain-excursion, with or without tents, will cure all the symptoms of the disease with the exception of an accelerated pulse and a panting respiration during active exercise. Canadian trappers who leave their supply-camp with a bad cough, get rid of it on the fifth or sixth day "out." They may get foot-sore, and, if game is scarce, hipped and homesick, but the feeling of haleness about the chest continues. Night-frosts do not affect it. Fatigues rather improve it. They may wake up with a feeling of frost-cramp from their chilblained toes to their shivering knees, but the lungs are at ease: no cough, no asthmatic distress, no stitch-like pains, no night-fever.

An old campaigner would laugh at the idea of "colds" being taken in the open air. He knows that they germinate in close bedrooms and flourish in musty beer-shops, but vanish in the prairie-wind. If he is a government teamster and sells his meat-rations for brandy, he may know that sun-heat and fire-water are burning his candle at both ends; he may see trouble ahead, but he is sure that it will not come in the form of lung-trouble. Koch's lung-parasites do not thrive upon a fresh-air diet.

After the *tuberculous cachexy* has once been subdued, a moderate daily dose of Nature's specific will suffice to maintain, or even to fortify, the recovered vantage-ground. A foot-trip across the continent would regenerate the respiratory organs, but even a stroll across the next meadow will be booked to the credit of our health account. The human organism is a savings-bank for the elements of vital strength, and in the form of fresh air it accepts the smallest deposits. In stress of circumstances, an hour per day of active exercise will help to keep the lungs *catarrh-proof*, and that hour may even be subdivided. Buy a large umbrella, and make it a rule to walk on your way to market, to your place of business, or to church; or at least part of the way, if the distance is great and your time limited. In the evening take a large satchel and go a mile out of your way to patronize a good fruit-dealer or a vender of old books—or fill the satchel at home, and earn the blessings of a poor family in the factory-suburb. Street-rambles should have a proximate object; the regulation-walk on general principles is too apt to be shirked on very slight pretexts. If you have a garden of your own, fence off a digging corner and prospect for geological specimens. If you have a wood-shed, import an old stump-log (hickory preferred), and do not be too particular about keeping your axe sharp. Ventilate your office; keep a stove and an overcoat in your workshop, and open the windows every now and then. Open the dining-room windows in the forenoon and the kitchen-windows in the afternoon; no force-ventilator can compete with the effect of a direct influx of atmospheric air. If you teach a class or work in a warehouse or counting-house, prevail upon the managers to ventilate the place during the dinner-recess, or else try to do your work in the airiest corner, near a window or near the door of a vacant side-room or hall. In ill-ventilated rooms the azote miasma has its centers of density that can be avoided with a little management.

But at all events get rid of the *night-air superstition*, and enjoy the blessing of an airy bedroom—the luxury, I might add. A natural instinct may be suppressed, but needs but little encouragement to resume its normal functions, like a river returning to its ancient channel. Thus the fresh-air instinct. In families cursed with the night-air superstition, children are ofter fuddled with miasma till they prefer it to fresh air, and dislike to sleep near an open window. But, in a single month, that aversion can be changed into a decided predilection, till

the cool breath of the night-wind becomes a chief condition of a good night's rest, and the closing of the bedroom windows creates a feeling of uneasiness not unlike the discomfort induced by an attempt to sleep with your head under the blankets. In the sleeping-dens of the French village-taverns, where, after September, the window-sashes are actually nailed down, the children of a hygienic home would pine for a draught of oxygen as a sweltering traveler thirsts after fresh water.

Besides open windows, Dio Lewis recommends an open fire-place and a good wood-fire all night; but that is a matter of taste: an extra blanket will serve the same purpose, and the danger of damp bed-clothes* in winter has been as strangely exaggerated as have the perils of cold drinking-water in midsummer.

In stormy nights a half-closed "rain-shutter" (a window-blind with broad bars) will keep the room perfectly dry without excluding the air. If the mercury sinks below zero, close every window in the house. Intense cold is a disinfectant, that purifies even the air of the hide-covered dungeons where the natives of the polar regions pass the long winter nights. In the dog-days, on the other hand, do not be satisfied with anything less than a thorough draught; open every window in and around the bedroom. Consumption has been recognized as a zymotic disease, and sultry heat favors the development of all morbific germs.

Where the prejudice against open windows has been cured, the cold-air superstition often lingers in the form of a repugnance to *out-door exercise in winter*. After the last of October thousands of convalescents suspend their morning rambles, and the hectic symptoms soon reappear. The aggravation of the disease may scare the patients into a warmer climate, but most of them would rather breathe sick-room miasma than the winter air of a high latitude. The truth is, that the prophylactic influence of the out-door atmosphere depends less upon its temperature than upon its purity, and for the open-air treatment of lung-diseases a cold, clear winter morning is more propitious than a dusty summer day. The contrast is shown in the effect. A single hour's exercise in the skating-ring or under a snow-covered wood-shed, a sleigh-ride, a brisk walk through an ice-glittering park, will ease the respiratory organs more effectually than a week of languid rambles through the dust and heat of an Italian *campagna*.

In larger cities, especially, a good frost defectates the lung-poisoning effluvia of the slum-alleys, while heat aggravates their offensiveness. In the cities of our Atlantic seaboard July is about the most unfragrant month in the year, and August the dustiest. Soon after the summer solstice wealthy invalids should, therefore, pack their

* "I shall not attempt to explain why damp clothes occasion cold, rather than wet ones, because I doubt the fact; I imagine that neither the one nor the other contributes to that effect, and that the causes of 'colds' are totally independent of wet, and even of cold" (Benjamin Franklin's "Essays," p. 216).

camping-gear for the Alleghany highlands, and arrange for their return by the end of October. Patrons of a transatlantic passenger-line had better go a month sooner, to avoid the midsummer nightmares of a superheated cabin. European tourists can combine the useful with the agreeable by doing their sight-seeing afoot; but they should remember that Alpine morning breezes can not always neutralize the bedroom air of a South-German tavern, and that sultry heat aggravates the effects of mal-ventilation.* The German, Austrian, and Russian shepherds stay the whole summer with their flocks, but, as a class, are nevertheless remarkably subject to pulmonary diseases, and for the following reason: They pass the night in a *Schäfer-hütte*, a sort of ambulance-box, eight feet by four, and six feet high, without windows, but with a tight-fitting sliding-door. This door the ill-advised proprietor shuts after dark, and breathes all night the azotized air of his Black Hole of Calcutta on wheels. In the morning he awakens with a hacking cough, superadded to a profuse perspiration and a feeling of nausea. The air of the mountain meadows gradually relieves the other symptoms, but not the cough, which finally becomes chronic; and, with exquisite facilities for the attainment of a patriarchal longevity, the slave of the night-air superstition dies in the forenoon of his life.

MAL-NUTRITION, combined with a tubercular diathesis, hastens the macerative (or "hectic") stage of the disease. Air is gaseous food, and the body of an ill-fed man who stints his lungs in life-air is thus suffering under a compound system of starvation. Hence the occasional rapidity in the development of tubercular consumption, and its frightful ravages in the homes of the poor, and in the stuffy tenements of French dress-makers and Silesian weavers, where a perpetual air-famine aggravates the want of bread.

FAT is the best lung-food, and, among all fat-containing substances, fresh, SWEET CREAM is about the best, and salt pork the worst. There is a close correlation between consumption and the various scrofulous affections; "pulmonary scrofula" is, indeed, sometimes used as a synonym of tuberculosis. The French physiologist Villemin found

* "The rate of life, and consequently the amount of disintegration, in any organized structure, depend in great measure upon the temperature at which it is maintained; and thus it happens that the production of carbonic acid from this source, at the ordinary rate of vital activity, is much more rapid in warm-blooded than in cold-blooded animals, and that the former suffer far more speedily than the latter from the privation of air. But, when the temperature of the reptile is raised by external heat to the level of that of the mammal, its need for respiration increases, owing to the augmented waste of its tissues. When, on the other hand, the warm-blooded mammal is reduced, in the state of hibernation, to the level of the cold-blooded reptile, the waste of its tissues diminishes to such an extent as to require but a very small exertion of the respiratory process to get rid of the carbonic acid, which is one of its chief products. And, in those animals which are capable of retaining their vitality when they are frozen, vital activity and disintegration are alike suspended, and consequently there is no carbonic acid to be set free" (Gurney Smith, "On Respiration").

that in Guinea-pigs, rabbits, and other animals, the symptoms of tuberculosis can be artificially produced by a repeated inoculation with scrofula virus; and in the children of scrofulous parents the inherited taint often leads to the development of a malignant form of tuberculosis. Consumptives should therefore avoid all scorbutific articles of diet: salt meat, pickles, indigestible made dishes, rancid fat, pungent spices, cheese, and all kinds of intoxicating liquors. A predilection for such diet is often encouraged by the circumstance that in the incipient stages of consumption it can be indulged without apparent inconvenience to the digestive organs. The victims of pulmonary disorders often enjoy an omnivorous appetite. But they should not forget that their diseased lungs act as an absorbent of all morbid matter, and that the immunities of the digestive apparatus are purchased at the expense of the respiratory organs.

Pathological conditions, involving an abnormal waste of tissue, require, indeed, an extra supply of nutritive aliments, and the patient may claim the right to indulge his appetite in regard to the quantity of his food, but he should earn that right by restricting himself in regard to the quality. His diet should be nutritious, non-stimulating, and slightly aperient; the regulation of the quantum may be trusted to the promptings of Nature. The first full meal, however, should not be taken before the morning exercise. Those who are in the habit of wasting the energy of the day's prime on the digestion of a massive breakfast may palliate their craving with a glass of sweet milk, or a piece of brown bread, dabbed with treacle or cream. Fresh cream, Graham bread, honey, beans baked with butter instead of pork, and a liberal dessert of such fruit as sweet grapes, pears, strawberries, or stewed prunes, at about 1 P. M. At six or seven a similar meal; for the sake of variety, perhaps buckwheat-cakes instead of bread, and apple-butter instead of honey. In point of quantity let the supper rival the dinner, with the proviso that the rules of the bedroom hygiene shall be duly observed, for, if the vigor of the digestive organs is aided by a liberal supply of oxygen, it is a fallacy to suppose that the night is an unfavorable time for the assimilation of a hearty meal. Animals rest after repletion, and some of them never sleep till they have a good meal to digest. There is no doubt that after meals neither mental nor muscular exertion is favorable to the performance of the organic functions which concur to effect the nutrition of the system. And, if the stomach can bear it, before going to bed an extra glass or two of sweetened cream may be taken—not as a food, but as a medicine. It is an established fact that *fat counteracts a tuberculous diathesis.* The inhabitants of the polar regions consume enormous quantities of non-nitrogenous food. Our negroes, to whom the climate of the United States must be semi-polar, lose no opportunity to gorge themselves with fat meat. The poor monkeys of our Northern menageries are ravenously fond of sweet milk and cream; instinct teaches them that

fat stifles tubercles. The dairy-districts of the chilly Netherlands enjoy a remarkable immunity from pulmonary diseases. Sandor Czoma, the Hungarian traveler, who passed several years in the highlands of Thibet, states that the Thibetan (Buddhist) monks prolong the lives of consumptives by heroic doses of clarified butter.

The Æsculaps of the future will issue their almanacs with a list of household remedies. The knowledge of a few simple dietetic correctives would enable thousands to dispense with the use of costly patent medicines. COMMON SUGAR is an effective receipt for depurating the morbid secretions of the air-passages. It relieves hoarseness, and in bronchial affections alleviates the painful, dry cough, by loosening the phlegm and relaxing the stringency of the laryngeal muscles. Various kinds of sweet fruits share this property, and the most palatable form of the specific is perhaps the saccharine element of good LAYER-RAISINS. California raisins are now retailed at ten to twenty-five cents a pound, and half a pound of a medium quality can be warranted to afford as much relief as a dollar-bottle of the best cough-sirup. Besides, the demulcents of Nature induce no unpleasant after-effect, while repeated doses of medicated sirup soon become nauseating. A quart of cold water, either pure or slightly sweetened, taken just before going to bed, is a pulmonary febrifuge, and a reliable preventive of night-sweats. It also promotes the easy breathing which to far-gone consumptives comes otherwise only after hours of troubled sleep. Dyspnœa, or want of breath, like dyspeptic asthma, can be greatly alleviated by an aperient diet: water-melons and buttermilk in summer, and baked beans, peas, or lentils, in winter. Combined with out-door exercise, digestive correctives often afford permanent relief from the distress of asthmatic affections, for that dyspnœa does not necessarily indicate an irremediable waste of pulmonary tissue is proved by the fact that it often occurs and permanently disappears with the symptoms that characterize the transient affections of the upper air-passages.

Permanence of relief is the best criterion for the value of a remedial agent. The cathartics and alcoholic stimulants of the old-school practitioners suppressed the symptoms of the disease, but the supposed relief was nothing but an interruption of a reconstructive process. While the vital forces were fighting the battle of life against the chronic enemy, we obliged them to suspend their efforts in that direction, in order to meet a more imminent danger at another point; for Nature can fight only one disease at a time. If an asthmatic person is seized with a climatic fever, the respiratory trouble is temporarily suspended: Nature, as it were, postpones the asthma-case in order to give her undivided attention to the fever-affair. Fever and ague give way to small-pox, a drunken man can be "sobered up" by an heroic dose of arsenic, and intoxication relieves the pangs of neuralgia, gout, and rheumatism—for a day. But, at the end of the day, the mal-

exorcised demon returns with seven accomplices, and Nature has to resume the original struggle with diminished chances of success—shorn of just as much strength as she had to expend in combating the additional enemy. The exorcist then repeats his dose, but finds that he has to increase the quantum: the exhausted system at last ceases to react against the provocation, and in order to obtain temporary relief the patient must resort to stronger and stronger stimulants.

There is a more excellent way: trust in the wisdom of Nature, and a careful husbanding of the vital forces—by CONTINENCE, for instance. Sexual excesses, combined with mal-nutrition, are such potent allies of pulmonary consumption that Dr. Zimmermann calls tubercles "*Thränen der Armuth und Reue nach innen geweint*" ("tears of poverty and repentance wept inward"). That dreadful disease known as "galloping consumption" often results from the co-operation of the three chief enemies of the human organism: impure air, intemperance, and incontinence. The causes of all violent (or painfully suppressed) MENTAL EMOTIONS should also be avoided. Give gambling-houses a wide berth. Deprecate quarrels, especially quarrels with superiors. Suppressed wrath has often resulted in fatal hæmorrhages. Consumptives need all the sleep they can get, and must abstain from night-work and nocturnal revels. They should also avoid crowded assemblies, not because of the excitement and the temptation to late hours only, but on account of the DANGER OF INFECTION. For consumption is a contagious disease, though not in the conventional sense of the word. The matter is this: the germs of tuberculosis have no direct effect on the respiratory organs of a healthy person, though cases are on record where the constant breathing of a tainted atmosphere has communicated the disease from husbands to wives, or from patients to nurses. But, after a tubercular diathesis has once been fairly developed, the diseased lungs become extremely sensitive to the *contagion* of all pulmonary diseases; the tubercle-seeds, as Dr. Koch's theory would explain it, fall upon a receptive soil—the sores of the half-healed *vomicæ*. Dr. Koch, of Breslau, traced the propagative principle of the tubercle-virus to the development of microscopic animalcula, and I predict that similar parasites will yet be discovered in the morbid secretions of the upper air-passages. This sensitiveness continues after the idiopathic symptoms of the disease have been brought well under control; and observation would show that a ten minutes' interview with a sufferer from catarrh, or a short visit to a reading-room, where swollen-faced children are hacking and coughing, suffices (often before the end of the first day) to prove the contagiousness of those affections.

But, if the danger is recognized in time, the virus can be *worked off* by out-door exercise. Catarrhs can thus be nipped in the bud. I speak from personal experience: I have tried the experiment at all times of the year, and always with the same result, even in one case

where my plan of operation involved a ten hours' march across a snow-covered mountain-range. I reached the camp foot-sore and almost feverish with exhaustion; but the catarrh, too, had exhausted its resources, and the next morning I awakened with half-healed feet and wholly-cured *bronchi*. One day of pedestrian fatigues had saved me two weeks of pulmonary distress.

Next to fresh air, active exercise is the best prophylactic:

"Dem Athleten wird vergeben
Was der Schwächling theuer büsst."

By stimulating the action of the circulatory system, gymnastics promote the elimination of morbific matter; *disease-germs are removed before they have time to take root*. Every gymnastic apparatus is worth dozens of patent medicines; the beneficial effect of the "movement-cure" is permanent, as well as safe and prompt. The five gymnastic specifics for pulmonary disorders are dumb-bells, Indian-clubs, long-handled oars, spears, and a grapple-swing. *Ger-werfen*, or spear-throwing, is a popular pastime of the Turner-Hall. The missile is a javelin of some tough wood, about ten feet long and as thick as a common axe-handle. It terminates either in an iron lance-head, or in a brass knob, to keep the wood from splintering. A rough-hewed log-man, with a movable head, forms the target, and the problem is to decapitate the figure from a distance of about twenty paces for tyros and forty for veteran lancers. The shock of the throw expands the chest, and has a magical influence on the stitch-like pains of a lingering pleuritic affection. It is a mechanical anæsthetic for all kinds of pulmonary disorders. The grapple-swing consists of a pair of iron (leather-covered) rings, suspended at a height of about four feet from the floor, and affords opportunities—if not *facilities*—for a great variety of acrobatic exercises. The complex evolutions are somewhat arduous, but even the simplest use of the contrivance—swinging to and fro like a pendulum—exerts a mitigating influence on the strictures of the respiratory organs, dyspnœa, and asthmatic troubles. *Faute de mieux*, trundling a wheelbarrow, with a gradual increase of the load, chopping or sawing wood, or grubbing out stumps with a mattock, is worth ship-loads of cough-sirup, though it is doubtful in what degree the individual predilections of the patient might bias his choice.

But people of means and leisure can remove that doubt by making out-door exercise pleasant enough to be preferable to any drug; and the following plan would combine, under the most favorable conditions, the best atmospheric, gymnastic, and dietetic remedies for the disorders of the respiratory organs.*

* The treatise on consumption will be concluded in our next issue, as the first of a series of articles on the hygienic treatment of the prevalent disorders of the human organization, including dyspepsia, pulmonary diseases, the alcohol-habit, rheumatism, and climatic fevers.

[*To be concluded.*]

SCIENCE AND CONSCIENCE.

By Professor THOMAS SERGEANT PERRY.

WHENEVER we find men's thoughts concerning any one of the main questions of life inclining steadily in a certain direction, there is some probability that we shall not be far astray if we expect to find a similar tendency in the way in which other questions are regarded by the same persons. Our experience tells us that this is true of individuals : a radical in politics is likely to be a radical in religion, and what is true of individuals is true of the race. The more we study the past, the more we shall be convinced of the uniformity of thought at different periods of history. Thus, the general awakening of interest that we call the Renaissance was not confined to art and literature ; it became a reaction against every form of mediævalism. It aided the great movement of religious thought and produced the Reformation, as it also followed the new channels of scientific investigation. The decay of feudalism that accompanied these new interests was far from being an accidental coincidence.

The pedantic sequel of the Renaissance, the limitation of interest to what was called good sense, which distinguished the age of Louis XIV in France, and, to speak somewhat crudely, what we may call the literature of the last century in England, was far-reaching in its effects : government and religion, as well as letters, rested on conventionalities. They were all affected by the prevailing reaction in favor of authority. In government, this took the form of monarchism ; in literature, that of relying on Latin models, and abandoning all the national forms of composition. The French Revolution was more than a mere political outbreak : it was but one form of a wide-spread revolt against the narrow limits which pseudo-classicism and monarchism had imposed on intellectual and personal freedom. The very logical coherence of the French, which had made their chains more binding than the clumsy imitations which other countries forged for themselves, made the revolution, when it came, thorough and terrible. What was a smoldering discontent burst then into a flame of vengeance. Romanticism, again, was not simply a literary movement ; its roots lay deep in the recognition of the fact that all human beings, without regard to their social position, are equally objects of interest to literature and art. The discovery was made gradually and almost simultaneously in literature and politics, that the aristocracy had no monopoly of importance. In short, toward the end of the last century there was a Renaissance of humanity ; and aristocratic principles received a blow from which they can never wholly recover. The revolution is not yet complete, and its course hitherto has been uneven. Some of the leaders, who in their hatred of classicism discovered that

civilization had a past, were so elated with their discovery that they stopped short to admire and make over again the past which they had painfully exhumed. There was a revival of mediævalism in art, in literature, in politics—modern imperialism is an instance of this—and that religion was not exempt is shown by ritualism in England. Yet the greater original movement has gone on, and in the realism that is beginning to affect art and literature, as in the spread of democracy, we see the natural growth of one inspiring thought.

If, then, we observe in the past the complex results of a single strong, animating influence, we may be justified in examining the life about us to see, so far as we may, how it is affected by contemporary thought. One of the most important influences now at work is doubtless that of science, which is of course as old as human curiosity, and is only new in its results. That the effect of the great advance in scientific thought has been to modify considerably most forms of religious belief can not be denied ; and, in spite of the many attempted reconciliations of the two, it is not difficult to see that some of the leading dogmas of Christianity are doomed. Fortunately, one of the rewards of the freedom that is given to science is a lack of venom in its attack, and, on the other side, there is an absence of bitterness in those whose opinions it unavoidably alters. There are, of course, exceptions ; modern science has not expelled arrogance from the world, and enlightenment has not wholly driven out bigotry. Yet, in the calmness with which the controversy is carried on, we see how wide-spread is the belief that dogmas are less essential than the truth which all men alike are seeking. As Professor Asa Gray puts it : "No sensible person now believes what the most sensible people believed formerly. Settled scientific belief must control religious belief." It is one of the time-honored jests which the late Lord Beaconsfield thrust into his last novel, that the religion of sensible people is what sensible people never tell. They may not, but their tolerance of new truths and the altered position of ecclesiasticism declare all that need be known.

The present interest in science is distinctly part of the revolutionary movement which demands, with restless curiosity, why everything should be as it is. This is the question that is put to every existing institution, and science often gives a serviceable answer. The answer is a leveling one to all conventionalities, because science concerns itself only about facts, and it is heard now because science can only exist where thought is free. Freedom of thought is a powerful solvent, and it is especially destructive to all the conventionalities which exist by means of the common agreement that they shall not be examined. We see that in politics the divine right of kings is called in question, and in the uniform tendency of modern times toward democracy the assumption of government by those who are governed. In social matters we perceive a similar movement toward the emancipation of the individual. All knowledge advances from vague generalities to

the comprehension of particulars, and as human beings have succeeded in understanding themselves they have thrown aside the convenient habit of dividing the rest of the world into vast homogeneous classes, and have recognized the dignity and importance of each individual of the race. This is most vividly reflected in the literature of the present day. We find in the romantic movement an expression of the renewed interest in man and nature: this interest was mainly felt at first simply in their picturesqueness; modern realism shuns the picturesque, as one form of the romantic exaggeration, and endeavors to treat human life as the man of science treats the objects of his study.

It would be singular if religion remained untouched by these movements. There would be no precedent for its escape from the common fate of all branches of thought. The Reformation was a democratic revolution. That its original fervor died out, and was succeeded by imitation of the forms that it had bitterly fought, is well known. When, toward the end of the last century, the great outburst of Methodism startled the Church of England out of its lethargy, it was not so clear as it is now that religion was experiencing the same change that was making over politics and literature. The campaigns of the Salvation Army, so far as they have more than mere temporary importance, give proof that lower social circles are feeling the general excitement. Can we suppose that the most important subject of man's thought is disregarded at the present time? Far from it; we see in the modification of the demands it makes on society a great change in religious feeling. We may observe the general relaxation of formal bonds in the more liberal ground that is taken by even the more conservative sects, and in the fact that the others insist rather on righteous living than on rigid belief.

May not some of this spirit of toleration be due to the recognition of the fact that laxity of belief does not necessarily connote immorality? Are not society and theology tending toward a generally acceptable *modus vivendi?* Is not ecclesiasticism dwindling before the change which has made itself felt in politics and literature, that is, before the growing importance of the individual? If this phrase meant that the individual has simply grown in conceit, the result would be absolutely intolerable; but if it implies that there has been greater development in the notions of right and wrong, and a more general recognition of the rights of conscience rather than of an outside force, the change, if it exists, may not be for the worse. The examination of these questions is a difficult matter. Some will answer them, without delay, in accordance with their already fixed opinions; and any one who gives them any consideration must be ready to acknowledge the difficulty of judging the present in anything like a satisfactory way. Contemporary life obviously lacks the perspective which is necessary to set in their proper place what is important and what is merely trivial and ephemeral. Yet we have before us a cer-

tain amount of testimony which will be all that is left for posterity to judge from, and in consulting this we may find material from which to form a tolerably satisfactory conclusion.

It is an easy definition of the literature of the last century that its tone was didactic. From the "Spectator" to the "Rambler" it abounds with the soundest instruction in morality, yet it may be worth while to notice that this is generally about the very rudiments of decorum. The "Spectator," for example, defended matrimony from the ribald attacks of the comic writers; it preached sound views concerning education, and it by no means neglected minor matters, such as "that huddled economy of dress which passes under the general name of a mob, the bane of conjugal love, and one of the readiest means imaginable to alienate the affection of a husband, especially a fond one" (No. 302). Elsewhere mention is made of misbehavior at church; improper conversation in public vehicles is denounced: these are the domestic and somewhat rudimentary lessons inculcated amid a great deal of social instruction concerning witchcraft, the folly of dueling, the beauties of the arts, etc. The work of the "Spectator" was summed up not inaccurately in these lines of an admirer, which are given in Drake's "Essays," illustrative of the "Tatler," etc.:

"Improving youth, and hoary age,
Are bettered by thy matchless page,
And, what no mortal could devise,
Women, by reading thee, grow wise.
. . . wedlock by thy art is got
To be a soft and easy knot. . . .
The ladies, pleased with thee to dwell,
Aspire to write correct, and spell."

There is a certain anti-climax in this outburst of praise, but it has the merit of accuracy, and it is easy to see how great are the advances made since the beginning of the last century in what we may call social morality.

Richardson, too, was didactic; but no reader of "Pamela" can avoid seeing that the heroine clings to her virtue quite as much for the reward she expects to win in this world as from any higher motive. The dangers portrayed in "Clarissa Harlowe" are somewhat remote in this more decorous age; and Sir Charles Grandison is a curious combination of heroic romance and catlike domesticity. The life that Fielding draws seems to us all very remote. Miss Edgeworth, again, took charge of the education of her contemporaries by writing a series of novels, each one of which exhibited the evil effects of one minor vice and the advantages of the opposite virtue. In all her stories, clever though they are, there is a great deal of the teaching with which Frank was dosed.

When at length society was tamed, hospitality did not mean drinking with your guest till one or both of you fell under the table, and

Squire Western became as strange a type as Achilles; the discovery was made that family life, which had promised perfect peace, had yet its own trials, and that a very admirable person who always told the truth and shut the door after him, who was deaf to flattery and to gross temptation, might yet be an extremely disagreeable companion. We demand something more of those with whom we live than the certainty that they will not stab us or burn the roof over our heads, and it is not enough that they abstain from breaking the commandments. We require profound respect for one another's rights, and we perceive in selfishness, in all its intricate shapes, an evil that was overlooked, except in its more violent forms, by those who were eager in the contest against more heinous offenses. Society now busies itself with what we may call the statute law of ethics, the greater principles being generally observed by common agreement. Vice, to be sure, is not extinct, but intemperance, for example, is frowned upon by society rather than tolerated and sanctioned, as has been the case in the past. In the novels of the day, which are the most faithful records of contemporary life, the problems that are discussed are those that directly concern the individual conscience. George Eliot's work is full of such questions, and, like many great writers, she has set the standard before the reader ahead of what it is in fact, so that it is, as it were, a goal toward which we are striving with what strength we may have. In this respect she resembles Goethe, who pushed forward the outer lines of criticism to a point which the main body of his successors is only gradually reaching.

Compare, for example, Miss Edgeworth's chilly prudence with George Eliot's tender sympathy with suffering, and the advance that has been made becomes clear. What would Miss Edgeworth have thought of such a statement as this—"That element of tragedy, which lies in the very fact of frequency, has not yet wrought itself into the coarse emotion of mankind. . . . If we had a keener vision and feeling of all ordinary human life it would be hearing the grass grow and the squirrel's heart beat, and we should die of that roar which lies on the other side of silence"? Yet, of course, George Eliot is far from despising the minutiæ of domestic life; she makes it the setting of the most delicate ethical problems. It is character and not incidents that she studies; not the glowing crimes that make the fascination of the melodrama, but rather the corruption or weakness that gives them birth. She traces the growth of sin in the human heart with a vividness that is really appalling. Who has ever read "Romola" without feeling that his own vanity, boasting, and shuffling performances are branded in the chronicle of Tito's slow moral decay? In "The Mill on the Floss," again, we have a typical representation of a form of domestic tyranny that can be matched in every household that we know. In "Middlemarch" we follow the struggle of generosity and a high ideal against incompetence and corroding selfish-

ness. In all her works the accidents of vice are carefully distinguished from the vileness of moral ruin; what tragedy there may be lies not in audacious crimes that make the fascination of the melodrama, but in the wrecked conscience of him who commits them. It is not long since fiction saw a hero in a murderer, who had at least the merit of boldness; now the analysis has been carried a step further, and novelists acknowledge, what we all know, that there may be evil-doers who are comparatively innocent, but that there is little to be said in behalf of a being sodden with selfishness, even if he do not offend against criminal law.

This distinction which the novelist draws between crime and wickedness is one that society itself is making, otherwise the novelist would not perceive it, and the growing interest in the discussion of the subject corresponds with the general increase in the value of the individual. Laws, we may perhaps say, concern masses; moral corruption is a personal matter that eludes the legislator. The ordinary citizen is law-abiding by nature and education; he does not consult the statute-book and trim his life in such a way as to avoid the grip of the constable; the policeman is his ally, not his foe. This alteration in men's way of modeling their lives has not been without effect on the position of the Church. Sermons are still preached that are remote from close connection with human interests, but there are many instances of the attempt that is making to save religion from the dry-rot of ecclesiasticism. Doctrinal exposition is giving place to simpler explanation of right and wrong, and to aid in the government of life.

What was once a hierarchy is becoming a democracy. We see a proof of this in the way in which books of casuistry are left stranded for the entertainment of the curious. Society has nothing more to do with those huge folios in which the leaders of the Church tormented themselves to devise possible sins for which they constructed ingenious reproofs. This treatment of the problems of sin reminds us of the barren and intricate exercises of the logicians who were contemporary with the casuists. Nowadays no one dreams of consulting a book to find out how wicked he has been, any more than an orator who wishes to influence his hearers practices with x, y, and z—the skeleton of the syllogism—to ascertain how he shall move the feelings of his audience. A man trusts to his conscience, to the sentiments of his neighbors, to tell him what his conduct shall be. The possession of the test of right and wrong has spread from a class to society at large. In the same way, with every year less stress is laid on the cosmogony of the Old Testament, and more on the ethics of the New. It is no longer demanded that we believe in the literal truth of Genesis, or in the ever-varying reconciliations, as they are called, with which theologians try not to be left behind by modern thought.

These modifications of ecclesiasticism—that is to say, the relaxation of dogmatism coincident with a general comprehension of mo-

rality—are part of the change which in matters of government is represented by the decay of aristocracy and the spread of democracy. "The theory of the Church," Mr. Stopford Brooke says ("Faith and Freedom," Boston, 1881, page 333), "is an aristocratic theory, and it has ministered to that imperialistic conception of God which in theology has done as much harm as despotism or caste system of any kind has done to society." In England the Church exists as a part of the general aristocratic system of a country in which non-conformity is detested mainly as a social stigma; in America we see the clearest proofs of the altered circumstances, and these are visible on every side. The formal side of ecclesiasticism loses its force, while ethical teaching gives and receives fresh life. Dogmas linger a couple of centuries behind what people really believe, and even the most conservative are far more liberal than they try to be, or than they say they are. Even the most fervent Roman Catholic refuses to believe that his Protestant friend is doomed to eternal damnation.

If theology is willing to satisfy itself with furthering right living and right thinking, its future is bright; if it demands assent to irreconcilable dogmas, it must in time disappear like everything which rests on sheer authority. Yet probably no age will ever be confronted with this direct question; the present one has come near it, and, while a century ago the general discussion was tabooed by the cautious, lest the whole social system should be swept by the board, it is now seen more or less clearly that men can think variously about dogmas without relapsing into barbarism. In time this will be generally acknowledged—what we now feel in our hearts—that the eternal laws of right and wrong, of justice and injustice, of truth and falsehood, are safe from the bungling of copyists, the destruction of wars, and the confusion of commentators.

This, however, is taking us from the question immediately before us, which is the relation that religion bears to contemporary thought. We can judge of what may be in store in the future only from the past and the present. If we fail to detect any modification of older ways of thought, there is no firm ground for prophecy about what is yet to happen. Yet we have seen Christianity molded into a church by the force of the current Roman ideas; we have seen feudalism triumphant in things terrestrial and things celestial; we have seen new freedom come into religion as into the rest of the world with the Renaissance, and we have seen a renewed reaction into old ideas following this freedom, as we see mediævalism in the fantastic robes and many candles of the Church when, in its turn, it was affected by the Romantic movement. In the wider freedom that begets science we see new tolerance for freedom of thought, and this freedom of thought can not fail to undermine some of the artificial constructions of the past. That it will destroy the essential principles of religion need scarcely be feared, any more than that science will expel literature.

Only what has within it the seeds of mortality can be killed, and religion and imagination are outside of science; but ecclesiasticism, which has been built by men, can be destroyed by men, just as literary conventions, which were the work of scholars, can be torn to shreds by scholars and writers.

PHYSICS IN GENERAL EDUCATION.*

By Professor T. C. MENDENHALL.

THIS is an "Association for the Advancement of Science." But the forces which have to do with aiding or retarding this advancement are so various that we are in danger of losing sight of some of them. We are mistaken if we suppose that science is advanced only through contributions which are the result of original research in our laboratories and libraries. Even if so narrow a view be taken, it will be admitted that the talent for research is fostered and encouraged, if not indeed created, by an atmosphere of recognition and appreciation. The existence of such an atmosphere is in itself a blessing, and its production is certainly worthy of our highest efforts.

To this end it is desirable and necessary to bring about a more general diffusion of accurate knowledge concerning the elementary principles and propositions of the science of physics, as well as some degree of familiarity with the methods of physical investigation. I do not refer, of course, to the demands or the necessities of those who expect to undergo a course of training for the purpose of becoming themselves physicists, but rather to the diffusion of this knowledge among the masses of educated people in general.

That this diffusion is not taking place to any great extent, and will not, according to natural laws alone, is patent to any observing physicist, who can not fail to have come in contact with prevailing and pernicious errors, which often carry the weight of repetition, and now and then of recognized authority.

I am aware that this is not an association of educators, and that pedagogics is not, as yet, one of the sciences specifically indicated as worthy of advancement at our hands; but, if the growth of a tree is to be made healthy and permanent, it is not safe to neglect the soil into which its roots penetrate. Train it and prune it as you will, to grow into vigor and strength it must spring from a rich and generous earth which, though beneath it and below it, must be in harmony with it in order to supply the proper and necessary materials for its sustenance.

* Substance of a vice-presidential address delivered before the Section of Physics at the Montreal meeting of the American Association for the Advancement of Science, August, 1882.

It seems, therefore, not improper to raise the question, What can this Association do, or, more specifically, what can this section do, to increase the efficiency of instruction in physics?

I do this the more willingly for the reason that a considerable majority of the members of the section are engaged in this instruction during the greater portion of the year. In America a few only are privileged to devote themselves to original research. Here instruction and investigation, to a great extent, go hand in hand, and it is generally admitted that it is better so. The teacher does not reach his greatest efficiency, indeed he must fail completely, unless he continues a student, not of the works of men alone, but of Nature herself. On the other hand, some of the best and most fruitful inspirations of the investigator spring from his contact with those to whom he is communicating the finished products of his work. The history of science goes to show that many, perhaps most of those who have contributed to its advancement, have been great teachers. We neglect our duty, then, when we fail to give attention at proper times and under proper circumstances to the improvement of methods of instruction.

Perhaps in no other department of science has a greater change in these methods been wrought during the last ten years than in physics. And yet this change has been going on in an irregular, unmethodical sort of a way. There has been little or no concerted action among those interested and engaged in the work. Although all have had practically the same end in view, each individual has, in the main, worked out his own solution of the problem in accordance with his own views, modified and often largely controlled by the conditions and restrictions to which he was subjected.

It is not surprising, therefore, that results attained should in many cases be widely different and, on the whole, not entirely satisfactory.

In this new instruction many things have been attempted that could not be, and some things that ought not to be, accomplished. That overburdened and somewhat obnoxious word *practical* has found a place in our vocabulary, and we hear much of practical instruction in physics, whatever that may mean.

The subject, considered as a whole, naturally divides itself into two parts, pertaining respectively to higher instruction and elementary instruction: instruction in the colleges and instruction in the schools. Let us briefly consider each of these.

In referring to higher or collegiate instruction, it will be remembered that I do not include that of the post-graduate course in the university, properly so called, for which laboratories for research are equipped and maintained, and to which students are admitted only when thoroughly prepared by previous training. Fortunately for American students, a few such courses in physics are now open in this country, and it goes without saying that those who are conducting

them do not need advice from us. It is for the large class of undergraduates who pursue the study of physics for a greater or less time that we may be concerned.

Contemporary with the recognition of the possibility of greatly improved methods of instruction was the recognition of the value of the more thorough study of physics as an element in what is called a liberal education.

These were alike the results of the tremendous strides made by physical science, beginning twenty-five or thirty years ago. Grand and beautiful generalizations commanded the admiration of men skilled in other departments of human knowledge, and equally wonderful applications of principles to practice touched our every-day existence upon so many sides as to draw forth applause from the millions who are without the "inner court." Physics thus found or forced its way upon the college curriculum to an extent much greater than had previously been thought possible or desirable.

A few keen-sighted men, combining in themselves, happily, the student and the teacher, recognized the fact that thorough instruction in physics implied and demanded the use of laboratory methods, such as had been utilized for some years in chemistry, and were rapidly coming into prominence in every other department of natural science.

Among these was, notably, Professor Pickering, whose establishment of a working physical laboratory for purposes of instruction, in the Institute of Technology at Boston, must be regarded as an epoch in the history of this progress; and with this also might be linked, although following at a little later date, the widely-known establishment made by Professor Mayer at Hoboken.

These were quickly followed by others in the East and in the West, and at the present time there are many institutions of learning in which the laboratory methods of instruction are in use, and whose equipment includes a so-called physical laboratory.

To all interested in the study of the present condition of this work I would especially recommend the very valuable "Report on the Teaching of Chemistry and Physics in the United States," prepared by Professor Clarke, of the University of Cincinnati, and issued about a year ago by the Bureau of Education. This report is full of facts of great value, and doubtless fairly represents the relative standing of collegiate instruction in these two important subjects at the present time.

Professor Clarke has classified the various courses of instruction in physics as follows:

1. Full course, including higher mathematical physics, advanced laboratory work, and research.

2. Full course, with mathematical physics and elementary laboratory work.

3. Course in general physics, involving a previous knowledge of trigonometry, and including laboratory work.

The other courses, up to ten in number, are elementary in their character, and do not concern the present investigation.

The report contains statistics gathered from nearly four hundred universities and colleges, agricultural colleges, and scientific schools. In nearly all of these the study of physics is pursued to a greater or less extent, although it appears that in some instances no report upon physics was forthcoming on account of ignorance as to what was meant by the word. Out of the whole number there were thirty-three institutions in which the instruction in physics fell within the limits established above. Of these there were four of the first rank, two of the second, and twenty-seven of the third.

In chemistry, however, laboratory instruction is to be found in at least one hundred and fifty institutions, the opportunities for instruction in this subject thus outnumbering those offered for similar instruction in physics in about the ratio of five to one. But it will be remembered that in this contest chemistry has many things in its favor, and that physics is handicapped by the great cost, relatively, of the first establishment, as well as by the lack of well-defined and systematic courses of instruction.

Taking it as a whole it will be admitted that there has been a rapid and, I believe, a permanent growth, and that the work has already become so extensive that it appears to be worth while to subject it to criticism, and to determine by conference and consultation what improvements, if any, might be suggested.

Admitting the necessity of the laboratory as a means of instruction in physics, two important questions present themselves: First, of the total amount of time given to the subject, what proportion should be spent in the laboratory? and, second, what should be the character of the work done there?

I shall not undertake to answer these questions, but will submit one or two conclusions which have been thrust upon me by observation and experience.

Concerning the first, something ought to be said. It will be remembered that the new instruction began at a time which was characterized not only by unusual scientific activity, but as well by what almost amounted to a revolution in educational processes. A great teacher had told us that we studied Nature in books, and when we met her face to face she passed unrecognized. There sprang up a new method, the essence of which was that the mysteries of Nature could not be known at second-hand; that a knowledge of things could only be obtained by a contact with things themselves. The use of the text-book fell into disrepute, and the student was encouraged to become his own authority. It was as if all men were to cast aside their maps, globes, histories, books of travel, etc., and

start out to obtain a knowledge of the world by visiting its different portions.

But it was soon found that many never succeeded in getting far away from home. It is true that there were those who, untrammeled by tradition, precedent, or authority, made bold excursions into the regions of the unknown, and returned richly laden with spoils, but these were the few; the many were found to require guidance and support for some time before they became able to carry on explorations on their own account.

The underlying principle of the new method was correct and must survive, but it was a mistake to give it universal and unrestricted application. The earlier and indeed much of the later instruction in physical laboratories was tinctured with this error.

By many we were advised that the proper course to pursue was to put into the hands of the student who, in many instances, had little or no previous knowledge of the subject, a few pieces of simple apparatus and expect him to rediscover for himself principles of physical science which, although now commonplace, were at one time as completely surrounded by difficulties to the human mind as are now, for instance, the principles of the dissipation of energy and the vortex theory of atoms.

The result of the crude experiments of the student was often to disprove the law which he was expected to establish; for he lacked that knowledge and training which would enable him to take into consideration the influence of secondary causes and conditions, and to determine or properly interpret the errors of experiment. Something was gained, it is true, in the way of familiarity with the methods of manipulation, but very little in the acquisition of real knowledge.

Even if this method of instruction be made reasonably successful, the actual information concerning natural laws which the student obtains must be largely superficial, often erroneous, and the rate of acquisition extremely slow. Far better would it be for him to begin his so-called practical study of the subject after becoming tolerably familiar with its general outlines and prominent features through the study of some reliable text-book, and especially after having armed and equipped himself with such a training in mathematics as will enable him to discuss understandingly the results which he obtains, to consider the limitations to which they are subjected, and the influence which has been exerted upon them by errors of various kinds.

In this matter, as with most others, we are likely to fall into extreme views. Some of us maintain that experiment alone is the key, by the use of which Nature's mysteries are to be explored, and we fortify our belief by pointing to Faraday, the greatest experimental philosopher the world has yet produced. We forget that Faraday was ignorant only of the outward, conventional symbols of mathematical reasoning, and that one of the greatest works on mathematical

physics, by one of the greatest mathematical physicists of modern times, is confessedly but little more than his interpretation.

Dazzled by the success of the leaders and representatives of another school, we proclaim that true success will depend on mathematical attainment, and that mathematical physics is the only physics worthy of the name. Here, again, the exceptionally brilliant few, who have succeeded under this training, stand as its exponents, and we fail to consider that, if adopted to the exclusion of the first, its results may be disastrous in the extreme. No better evidence of this need be furnished than is found in the remarks recently made by Mr. G. H. Darwin, concerning a contest for honors, in what is generally admitted to be the greatest school of mathematics and mathematical physics in existence. Mr. Darwin, who was one of the examiners, says: "The subject which exhibited the average weakness of grasp most flagrantly was thermo-dynamics. A great many men had read something of it, but very few really understood what they attempted to explain. Extraordinary muddle and confusion was sent up in answer to a question on the absolute scale of temperature. On another question, while the very elements of the subject were unknown to those who answered, the same men reproduced faultlessly the algebraic calculation of the thermo-dynamic function for a perfect gas."

Mr. Darwin also strongly recommends such a change in the style of questions as that half intelligence may be more stringently treated, and men induced to read less and master more, and to gain a comprehension of physical principles.

There can be little doubt but that the experimental and mathematical study of the subject should go on together, assuming, of course, a sufficient preliminary training in pure mathematics.

What seems desirable, therefore, at least in some instances, is less experimental work on the part of the student, and more thorough and exhaustive discussion and examination of what is done.

This leads at once to the consideration of what ought to be the nature of the work done in the laboratory. The limits to which I am confined will not allow me to enter into any lengthy discussion of this important question.

I will remark, however, that in my opinion there is much done which is neither desirable nor necessary. As a rule, quantitative work alone, and that the best possible under the circumstances, should occupy the time of the student. I would relegate to the lecture-table of the instructor all illustrative experiments and qualitative work necessary to a good understanding of the underlying principles of the subject, which every student should possess when he enters the laboratory. That which he gets which is of most worth in his course in a physical laboratory is not a familiarity with the principles of the science, but a training in the methods of investigation in use among physicists, including a knowledge of the use and abuse of experiment and the ne-

cessary limits of our knowledge derived therefrom. The study which he ought to make of errors, instrumental and accidental, will be of great value to him in other fields than this.

As an illustration of the lack of this sort of training, I may be allowed to mention a lecture to which I listened recently, delivered by the chief engineer of one of the leading railroads in the country. The subject was the "Great Pyramid," and in speaking of certain measurements taken in the interior he declared the results, which were given in feet, inches, and thousandths of an inch, to be *absolutely accurate*, taking especial care to disclaim anything in the nature of an approximation.

I need hardly explain that he was declaiming against the introduction and adoption of a system of metrology which has done and will continue to do much to increase the simplicity and accuracy of all measurements.

I have said that this quantitative work should be of the best quality possible. It is better for the laboratory to contain a few instruments of real precision than a large number of inferior performance and accuracy. It is not a matter of great importance upon which particular department of physics a student shall spend his time and strength. The underlying principles of this method of study are common to all, and it is a matter of experience that when a student has successfully accomplished a tolerably exhaustive investigation of one topic, involving, it may be, but a single instrument with its accessories, he is upon his feet for the remainder of the course.

To sum up, the course of study in physics for the undergraduate collegian, which I have tried to indicate, should include a sufficient training in mathematics to enable him to apply his knowledge with ease and facility to the more common physical problems; a thorough and exacting course of text-book and lecture-work, in which the application of his mathematical knowledge would be made, and during which all illustrative experiments necessary to a complete understanding of the text should be exhibited by the instructor from the lecture-table; and, finally, this to be supplemented by a course in the laboratory in which more attention is paid to the quality than to the quantity of work done; during which every problem is discussed, as far as possible, both mathematically and experimentally, and especial attention is given to the discussion of the results of experiment, and of the more elementary portions of the theory of errors.

Considering the work as thus divided into three parts, I am unable to see which is the least essential.

I desire to say a few words in regard to instruction in physics in the school, about which we are, apparently, more remotely concerned. Even greater reform is demanded in this direction than in the other. Although there are numerous American text-books, I venture the remark that none have properly combined, in their making, the experi-

ence of the class-room with the critical knowledge of the scholar. We may import them from Europe, it is true, as we must also our more advanced text-books, but, although in the main vastly superior to our own, they are still not entirely suited to the wants of American schools and American pupils. These books, in the hands of teachers who know little or nothing outside of the books they use, and often falling far short of that, serve to put the instruction in elementary physics in this country in a condition over which no one can grow very enthusiastic; and this, in spite of the prominent place which has been given it and the considerable attention it has received. Unsound doctrines and absurd theories are promulgated because of an inability to distinguish the ring of genuine metal. These become so deeply rooted that it is difficult and often impossible in after-years to clear them away.

I believe it to be possible for this Association to exert a strong influence in favor of an improvement in the character of the instruction in physics in both elementary and higher institutions of learning in America. Much of it at present does us no credit, and must eventually do us much harm. At a meeting of this Association in Nashville, five years ago, a committee was appointed to report upon science-teaching in the public schools. At the Boston meeting, two years ago, this committee presented a report which embodied much thought upon the subject, and was replete with just and keen criticisms of present systems. It is greatly to be regretted that this report can not have found its way into the hands of those whom it would most benefit. A wide distribution ought to have been secured, and I am convinced that it is not yet too late to remedy this error.*

The same gentlemen were continued as a committee to report upon the "Best Method of Science-Teaching in Public Schools," and it is to be hoped that a scheme may be presented at no distant day. I will venture the opinion, however, that the best results will not be obtained until this, or a similar, committee shall work in co-operation with representatives of the public schools themselves, and I would suggest the feasibility of securing such co-operation through the National Educational Association.

No such difficulty is in the way of securing an improvement in the teaching of physics in colleges and universities, for those most interested are, in the main, a part of this Association and of this section.

I will not venture to suggest in what manner the Association might best make itself felt in this matter, although I think that would not be difficult to ascertain. I have only endeavored to direct attention to some of the salient features of the problem, and to ask its consideration at the hands of many members of the section who come in almost daily contact with it, and who will, I am convinced, sustain

* This report will appear in the next issue of "The Popular Science Monthly."

me in the belief that it is not unworthy to be brought before this body.

In preparing this discussion of the subject, I have not had access to such information as would have been desirable concerning the work which is being done in many institutions, nor have I been able to consult with others who are especially engaged in its management. Indeed, it was this very lack of accessible information, this very impossibility of personal consultation, with which I met in the outset, that convinced me of the importance of directing the attention of the section to the subject.

What the section *could* do in the direction indicated seems to be tolerably clear and certain. Whether it is wise or desirable that it should undertake to do anything is a matter which I willingly leave for it to determine.

MICROSCOPIC LIFE IN THE AIR.

By LOUIS OLIVIER.

ANCIENT Pantheism animated all nature. Gnomes in caverns, naiads in springs, sylphs in the air, represented life, pervading everything. Twenty centuries having passed, science has resuscitated these elementary genii under the form of organic germs; and we are forced to-day to recognize that the reality surpasses all the bold conceptions of the fable. From pole to pole the atmosphere transports myriads of microscopic animals and plants. They are counted by hundreds in each cubic metre of air that we breathe in Paris. Developing themselves in the organic infusions into which they fall, they soon determine their complete decomposition; and they play their parts in virulent diseases and in fermentations. No doubt is permissible on this point after the admirable labors of M. Pasteur; and every day a new workman brings his stone as a contribution to the grand edifice of which this illustrious physiologist has drafted the plan and himself laid the impregnable foundations.

A considerable work has just appeared on this subject. For several years, M. Miquel has pursued interesting researches upon the microbes of the air; and, in addition to the regular publication of his investigations in the "Annuaire" of the Observatory at Montsouris, he has just completed an important memoir, which includes valuable facts respecting these organisms. We propose to show here how this department of science has been developed, and what means of carrying out its objects it possesses. F. A. Pouchet devised the *aëroscope* that bears his name, for collecting dust from the air. It consists of a small cylinder connected with an aspirator; a disk of glass coated

with glycerine, and placed at the bottom of the cylinder, receives the jet of air which is produced by the aspirator. The glycerine retains the corpuscles which are brought in by the current, and it is then easy to observe them. This apparatus has been modified in various ways,

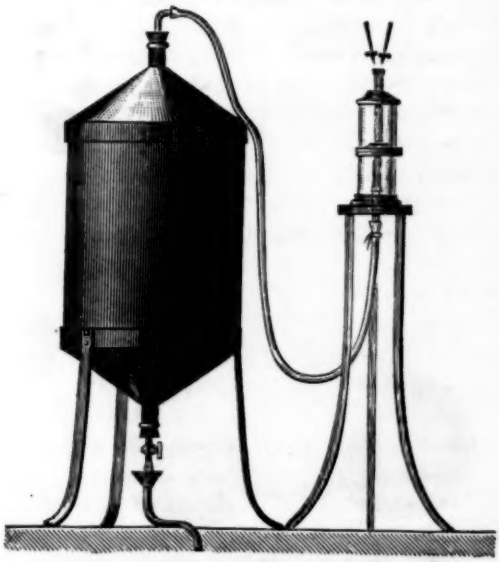


FIG. 1.—POUCHET'S AËROSCOPE.

but with it, or something like it, the earlier investigators, MM. Pasteur, F. Pouchet, Maddox, Douglas Cunningham, and others, have explored the atmosphere. It did not take long to discover that the air around us contains remnants of articles that we use existing in the condition of impalpable dust. Wool from our clothing, cotton, silk, starch, are floating in it, associated with fragments of various kinds—butterflies' scales, dried *tarsuses* of insects, feather-barbs, and skeletons of little worms. Pollens of the coniferæ and of numerous plants are abundant in it during the floral season. Particles of mineral matter are also found there, among them those curious spherules of meteoric air which have been described by M. Gaston Tissandier.*

Attention is, however, most strongly fixed upon the number and variety of spores of cryptogams of which the air operates as a vehicle of dissemination. Germs of the common molds, and the reproductive cells of the algæ that live on the roofs of houses, on walls, and on damp earth, are nearly always abundant. M. Miquel has tried to determine the laws that govern the appearance of these plants in the atmosphere. He first counted them, by disposing his aëroscopes so that they should register the volume of the air passing through them,

* See "Popular Science Monthly," July, 1880, article "Atmospheric Dust."

and estimating the spores deposited by those volumes, and from this deducing the number of spores contained in a cubic metre of air. Repeating these measurements every day and every hour for several years, and taking care to notice all the anterior or concomitant meteor-

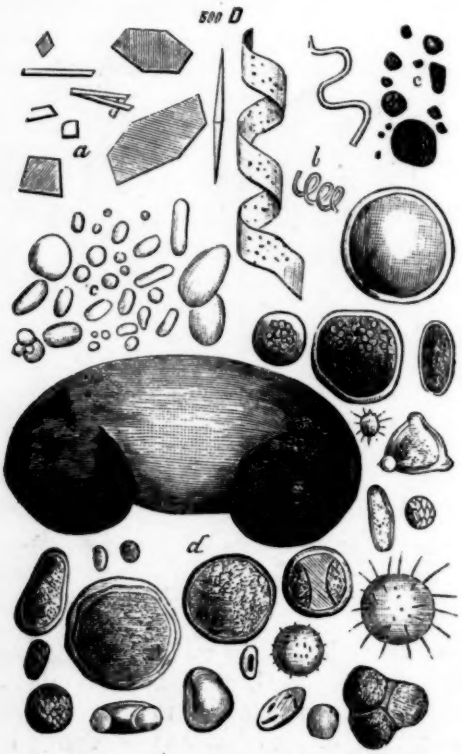


FIG. 2.—POLLEN AND DUST IN THE ATMOSPHERE.

ological conditions, he succeeded in defining the influence of the seasons, and of temperature, dryness, and moisture in the progress of the phenomenon.

This method, applied at the Montsouris Observatory, shows that the number of mold-spores is weak in January and February, diminishes in March, and rises in April; the increase is very sensible in May, and the maximum is reached in June. The number then diminishes slowly till October, considerably in November, and reaches a minimum in December.

It may be said, generally, for the locality where the experiments were made, that a cubic metre of air contains on the average seven thousand mold-spores in December, January, and February; twelve thousand in May; thirty-five thousand in June; twenty-three thousand in August; fourteen thousand in October, and eight thousand in November. If, instead of considering the means of several years, we

compare different periods of the same year, we shall not find the variations so regular. Sometimes the number of germs diminishes while the heat is increasing. In that case the effect of temperature is masked by the preponderance of another factor — the hygrometric condition of the air. This fact is explained by remembering that

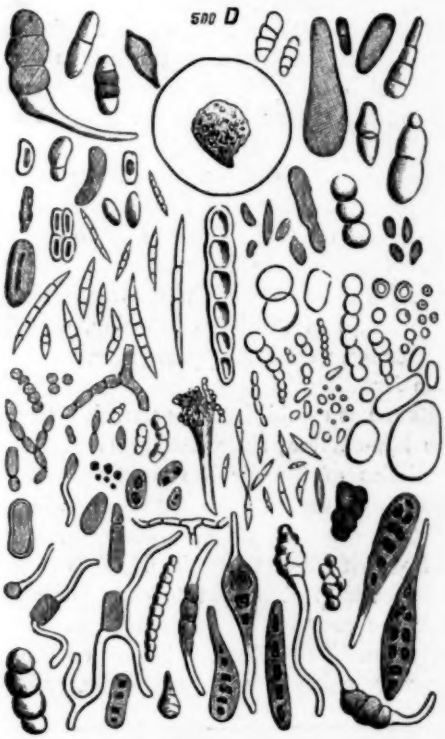


FIG. 3.—SPORES OF ALGÆ AND MOLDS IN THE ATMOSPHERE.

the development of molds is dependent upon both heat and moisture. The effect of moisture, however, varies according to the season, and with changes in temperature. Dry weather diminishes the number of germs in summer, and increases it in winter, while moist weather operates in an inverse manner.

Storms in the pleasant season are followed by a growth of cryptogamic vegetation, and purify the atmosphere for only a very short time. Fifteen or eighteen hours after a rain, says M. Miquel, "the spores appear to be five or ten times as numerous as before. On the other hand, mineral dusts and several kinds of microbes continue to be rare till the moisture which has caused them to adhere to the blades of grass and the moist soil of the surface has dried away."

These investigations, while they are profitable in a purely scientific aspect, are also destined to be of service in agriculture and hygiene.

As M. Miquel remarks, the use of aëroscopes will be of value for the discovery in the air of the germs of the molds which attack our cereals. Regarding the etiology of certain contagious affections, he continues: "It does not seem to be proved that the various spores introduced into our economy, to the number of 300,000 a day, or 100,000,000 a year, are perfectly innocuous. The appearance of thrush in the mouths of young children and in the respiratory canals of the dying seems to demonstrate also that the molds form a part of the class of parasites which are ready to take possession of our organism whenever it presents a vulnerable point or a point of weak resisting power."

M. Pasteur has long insisted on the utility of these researches. "I believe," he wrote in 1862, "that it would be of great advantage to multiply the studies on this subject, and to compare in the same place at different seasons, and in different places at the same time, the number of corpuscles disseminated in the atmosphere. Our knowledge of the phenomena of morbid contagion, especially during the prevalence of epidemics, would, it appears to me, gain from researches prosecuted in this direction."

Since M. Pasteur has established the parasitic character of zymotic diseases like the hen-cholera, sheep-rot, septicæmia, measles, etc., the micrographic statistics of the air has risen to a considerable importance. It has had, however, to concentrate its efforts chiefly upon a class of rudimentary organisms very different from the green algæ and the molds of which we have spoken. This group is the one to which the viruses belong. The plants composing it, and which are designated under the common denomination of bacteria, escape the process of numeration in use for the higher cryptogams. In consequence of their extreme minuteness and refractive power, they are

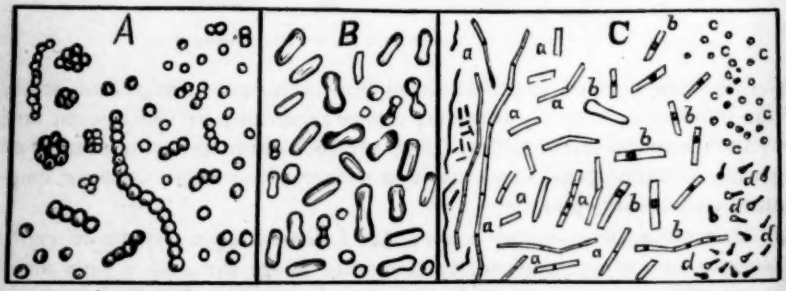


FIG. 4.—SPECIMENS OF BACTERIA. A, *Micrococcus* in isolated cells or aggregated into balls and strings; B, *Bacterium*; C, *Bacillus*; *a*, bâtonnets (adult bacilli); *b*, bâtonnets with spores; *c*, isolated spores; *d*, germinating spores.

invisible, and unrecognizable in the preparations of the aëroscopes. Their existence in the air was long denied, and the proof that they abound in it only dates from the experiments that were instituted by M. Pasteur for the solution of the question of heterogeny. The meth-

ods he devised are the ones that are still used to detect the presence of these plants in the atmosphere. Generally, these methods are founded on the fact that organic liquids become peopled with microphytes, or remain unchanged, according as the air comes to them charged with its normal quantity of germs, or after having been cleared of them by filtration. We can, therefore, examine the bacteria in the atmosphere by causing the air or the rain-water containing them to pass into liquors favorable to their nutrition, but previously free from them. Liquids for the culture of bacteria are easy to procure. Among them are the mineral solutions of Pasteur and of Cohn, infusions of hay and of turnips, neutral urine, broths of chicken or beef, and Liebig's extract. It is, however, very hard to obtain such liquids absolutely pure of every living being. Eminent physiologists have thought that all the germs could be killed by boiling them for a considerable time. Apparently the protoplasm, being an albuminoid substance, would be coagulated at a temperature of between 167° and 176° ; but very exact experiments have shown that while the protoplasms of different living beings belong to the same class of substances, they are not identical. Marked differences in this respect have been perceived even in the same beings. Thus, in the bacillus the protoplasm of the developed organism and that of the spore are not of the same quality. The former is in active life, the second in a state of life so low that it appears latent. A spore of this kind, as M. Chamberland has observed, will resist boiling water for hours, while the *bâtonnet* which is developed from it would perish rapidly in the same water at 122°.

M. Koch has conceived a method of discontinuous heating to sterilize liquids that are coagulable by heat. He raises his liquid to a temperature of not quite 158° to kill the adult bacteria ; then having cooled it, to give the spores time to germinate, he raises it again to about 158° ; and he believes that he can in this way destroy all the germs. M. Miquel makes a just criticism of this singular theory. We arrange that the spores of the microbes "must germinate in twelve or twenty-four hours, so that we may surely kill them if they go into the trap we set for them. But some of the germs may be obstinate or hardy, and we make a new trial, and for prudence a third and a fourth trial, after which we assume that all the bacteria have been destroyed. Unfortunately for the method of discontinuous heating, there are wary germs the development of which does not begin till after the fifth, the tenth, and even the twentieth day, and which, far from being stimulated in their growth by the successive heatings, at every repetition shut themselves up more closely in their latent seed-life. This method of sterilization can not, then, be depended upon."

A still more subtile cause of error must be guarded against. Cohn's mineral liquid will remain clear for an indefinite period after having

been exposed to a heat of from 158° to 167°, without being free from germs; for, if we afterward add a quantity of broth which has been sterilized at 230°, the mixture of the two liquids, which, separate, would have continued perfectly limpid, will shortly swarm with bacilli and other organisms. Cohn's liquid can not be fully deprived of active germs till it has been boiled for four hours. If, continues M.

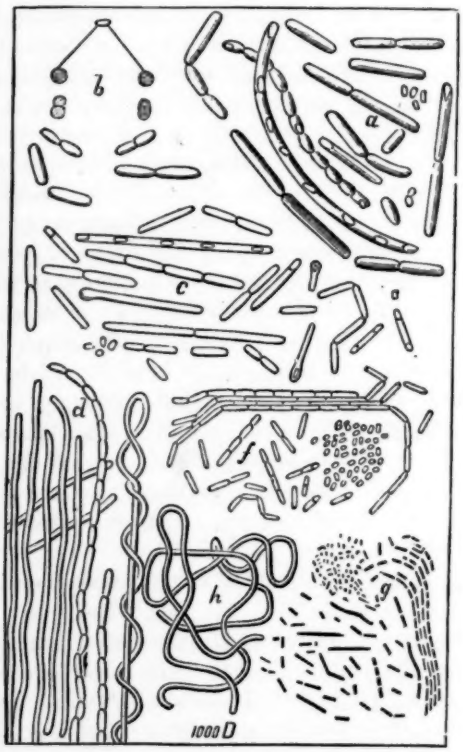


FIG. 5.—BACILLUS OF THE ATMOSPHERE MAGNIFIED 1,000 DIAMETERS.

Miquel, we add sewer-water that has been heated for several hours in an hermetically sealed retort at 176° to Cohn's liquid which has been sterilized at 230°, and place the mixture in a hot bath, nothing will appear in it even after a month. Apparently it is perfectly free from living germs. But if a few drops of it are placed in a broth, also fully sterilized, the broth will in a day or two appear full of bacilli.

We must, then, unless we would expose ourselves to grave errors, distinguish between apparent and real sterilization. While beef-broth, neutralized with potash and heated to 230°, will remain sterile for an indefinite time, it is a good plan with other compositions and for particular bacteria to attain a temperature as high as 302°.

Heat, unfortunately, modifies the composition of organic liquids,

and diminishes their nutritive properties. To obviate this, we must find means to sterilize the liquids without heating them. Filtration has been employed, and a number of adaptations of apparatus have been devised by means of which this object is accomplished satisfactorily.

In order to study the germs in the air, we must not only possess a sensitive and wholly pure liquid, but must have means of arranging it for the cultivation of the organisms, under such circumstances that we may be sure it shall contain no germs except those that are derived from the air we introduce for the experiment. MM. Chamberland and Miquel have employed simple apparatus which seem to effect this purpose perfectly.

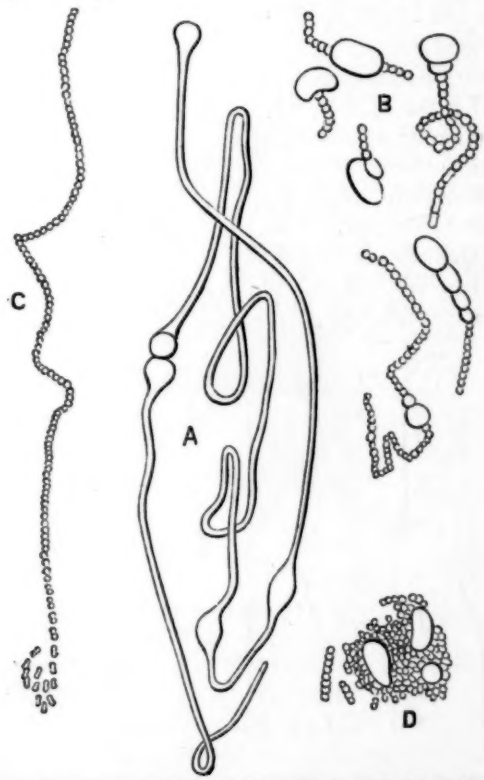


FIG. 6.—MICROCOCCUS BACILLIFORMIS (after M. Miquel). A, adult plant; B, examples of hypertrophied cells; C, chain at maturity; D, chain destroyed. Magnified 1,000 diameters.

If the experiments are made with rain-water, to ascertain the number of germs it collects in passing through the air, it may sometimes happen that, when a determined volume of water is evenly distributed in a considerable number of the cultivation-tubes, only a part of the tubes will become troubled. Generally, it may be said that if the water contains as the average one bacterium per cubic centimetre,

nearly every tube that receives a centimetre of the water will become turbid; but, if the number of bacteria is only half as many, half the tubes will remain sterile. This rule, though inexact in theory, seems to prevail with an approach to exactness in practice. M. Miquel applied it to the estimation of the bacteria in rain-water, and found that at the beginning of storms the water of precipitation contained a considerable number, amounting sometimes to as many as fifteen per cubic centimetre, and that the number immediately began to diminish; but that, strange to say, "after two or three days of moist and rainy weather the meteoric water frequently contained more bacteria than at the beginning of the rain: As the atmosphere was then in a condition of extreme purity—a fact that was established simultaneously by the statistics of the germs in the air—it seemed to be shown that the bacteria could live and multiply in the very midst of the clouds, or, perhaps, that the clouds might in their course through space charge themselves with a very valuable contingent of germs."

In studying under the microscope the development of these little organisms, in the preparations of which they have taken possession, a very curious evolution of one of the microbes of the air is revealed. The organism is a bacterium, which presents at first sight the characteristics of a very long, filamentous *bacillus*. M. Miquel affirms that he has seen this organism afterward divide itself into segments of unequal size, in such a way as to form strings of micrococci. The observation deserves consideration, for, if it is confirmed, and the

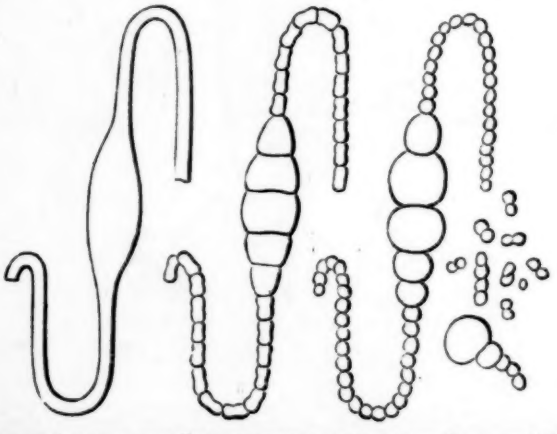


FIG. 7.—SUCCESSIVE PHASES IN THE TRANSFORMATION OF THE SAME ORGANISM (after M. Miquel). Magnified 1,000 diameters.

habit is proved to be general, it will establish a line of union between the different types of the inferior algæ, which were believed to be fixed, but may be, after all, only transient genera.

It is important to have the microbes collected in the broth of the tubes sown in different kinds of liquors. Such treatment furnishes

the only means of discovering the nature of the organisms, for characteristics deduced from their shape are of no significance. Most frequently they can be distinguished only by the fermentations they produce. Numerous experiments based on this principle will be required for the exact determination of the bacteria in the atmosphere. In the present condition of the science, we have to limit ourselves to the general statistics of the *Micrococci, Vibrios, Bacteria, Bacilli,* and *Cladothrices* that live in the air, without undertaking to classify in any precise way all the beings comprehended under each of these denominations.

The observations conducted at the Observatory of Montsouris show that there are on the average eighty bacteria in a cubic metre of air. The highest number was observed in the fall, the lowest in the winter. There were found fifty bacteria in December and January, only thirty-three in February, one hundred and five in May, fifty in June, and one hundred and seventy in October. The diagrams of daily observations

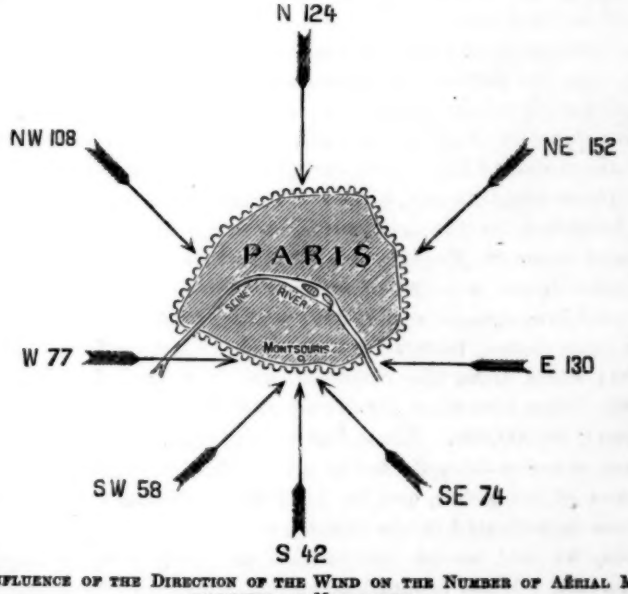


FIG. 8.—INFLUENCE OF THE DIRECTION OF THE WIND ON THE NUMBER OF AÉRIAL MICROBES COLLECTED AT MONTSOURIS.

show that the number of spores of these algæ increases with the temperature. Inversely to what takes place in the case of the molds, the number of the schizophytes, small in rainy weather, rises when all the moisture has disappeared from the surface of the soil. The counteraction of moisture is stronger than the direct action of temperature; and this fact accounts for the rarity of the bacteria after the great rains of February, April, and June. Still a long period of dry weather does not appear to be favorable to the development of the plants.

The number rises at first during the hot season, but diminishes under the influence of a progressive desiccation toward the second or third week.

The diminution in hygrometric conditions manifested in September and October explains the recrudescence of the bacteria during these months. Some micrographers have suggested that the germs may be transported by the vapor of water; but M. Miquel's experiments invalidate this hypothesis, and indicate that the evaporation of water from the surface of the ground never carries any schizophytes with it. On the other hand, numerous tests have shown that dry dusts, especially those of hospitals, proceeding from substances in a state of putrefaction, sanious pus, and the dejections of the sick, are charged with microbes. Great agglomerations of men furnish the most of them. According to the measurements made in the Rue de Rivoli and Montsouris, the air in the interior of Paris is nine or ten times richer in bacteria than that in the neighborhood of the fortifications. At the observatory, the winds from the north bring many more than the winds from the south.

The vertical distribution of the microbes also shows that they come mostly from the dirt of our streets and houses. While a cubic metre of air at the top of the Pantheon contains only twenty-eight of them, the same quantity of air in the Park of Montsouris contains forty-five, and in the mairie of the fourth arrondissement, four hundred and sixty-two. These numbers are, however, insignificant in comparison with those furnished by the analyses of sewer-waters. We give a few specimens from M. Miquel's analyses, in which is shown the number of microbes found in a litre of water from each of the sources named: Condensed atmospheric vapor, 900; water from the drain of Asnières, 48,000; rain-water, 64,000; water of the Vanne (Montrouge basin), 248,000; water from the Seine (drawn at Bercy), 4,800,000; water from the Seine (drawn at Asnières), 12,800,000; sewer-water (drawn at Clichy), 80,000,000. These figures represent the minima. Left to stagnate, sewer-water putrefies in a very short time, through the multiplication of its germs, and the microbes become a thousand times as numerous as indicated in the summary.

Thus, we see, we are surrounded on every side by myriads of schizophytes. What proportion, among these minute inhabitants of the atmosphere and the waters, have a part in producing contagious maladies and the epidemics by which the populations of our large cities have been decimated at times? We do not know yet. The continuation of the statistical researches that have been begun at Montsouris, and the microscopic analysis of the air and of water, particularly of sewer-water, cultivation, botanical and physiological investigation, and inoculation with the resultant germs, will certainly conduct to the solution of the problem. Then only, having become acquainted with our enemies, shall we be able to destroy them. The precautions that

we take against such evasive foes—working as we do in the dark—by using antiseptics, are evidently insufficient. A substance that kills one bacterium may not hinder the development of its neighbor, and our employment of antiseptics is always dependent upon their specific action. There exists no universal remedy against microbes. Science alone can teach us how to contend against them.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

HOW MUCH ANIMALS KNOW.

By F. A. FERNALD.

NO phenomena in nature are watched with more interest by all classes, young and old, ignorant and educated, than the displays of intelligence in the inferior animals. From the dog, which occupies a position of intelligent companionship with man, down through the less favored species even to the lowest groups of animal life, we see manifested all degrees of that wonderful attribute which in its highest perfection constitutes the human mind. It is not surprising that these various indications of something like a capacity for thought should be of universal interest, but it also has a deeper meaning, which it is the office of science and philosophy to explore, and which relates to the profound and mysterious problem of "mind in nature." Before philosophy can make much headway with this question, however, there must be a more critical scrutiny of the question as to what degrees of intelligence different grades of animals really possess. Dr. George J. Romanes, in his recent interesting book on "Animal Intelligence," engages with this subject as a scientific question of comparative psychology, and he has done a good deal toward winnowing away the fictions that have become current in relation to the mental manifestations of the lower tribes, and has given us probably the most trustworthy book extant upon the subject. We cull from his pages a series of representative instances of animal sagacity which the reader will find both entertaining and instructive.

It is common to quote the oyster as the lowest example of stupidity, or absence of anything mental, and, as it is a headless creature, the accusation might not seem wholly unfounded. Yet the oyster is not such a fool but that it can learn by experience, for Dicquemase asserts that, if it be taken from a depth never uncovered by the sea, it opens its shell, loses the water within, and perishes. But oysters taken from the same depth, if kept in reservoirs where they are occasionally left uncovered for a short time, learn to keep their shells closed, and then live for a much longer time when taken out of the water.

This fact is also stated by Bingley, and is now turned to practical

account in the so-called "oyster-schools" of France. The distance from the coast to Paris being too great for the newly-dredged oysters to travel without opening their shells, they are first taught in the schools to bear a longer and longer exposure to the air without gaping, and when their education in this respect is completed, they are sent on their journey to the metropolis, where they arrive with closed shells and in a healthy condition.

The social life of ants has many parallels to that of the barbarous races of human beings. Thus, the habit of making slaves is said to obtain among at least three species of ant. A community attacks a nest of another species in a body; there is a great fight with much slaughter, and, if victorious, the slave-makers carry off the pupæ of the vanquished nest in order to hatch them out as slaves. When the pupæ hatch out in the nest of their captors, the young slaves begin their life of work, and seem to regard their masters' home as their own; for they never attempt to escape, and they fight no less keenly than their masters in defense of the nest. In the nests of *Formica sanguinea* the comparatively few captives are kept as household slaves. They never leave the nest, and so all the out-door work of foraging, slave-capturing, etc., is performed by the masters.

F. rufescens, on the other hand, assigns a much larger share of labor to the slaves. In this species the males and fertile females do no work of any kind, and the workers, or sterile females, though most energetic in capturing slaves, do no other kind of work. Therefore the whole community is absolutely dependent upon its slaves. Huber shut up thirty masters without a slave and with abundance of their favorite food, and also with their own larvæ and pupæ as a stimulus to work; but they could not feed even themselves, and many died of hunger. He then introduced a single slave, and she at once set to work, fed the surviving masters, attended to the larvæ, and made some cells.

A predatory expedition of ants for capturing slaves, or robbing the storehouse of another nest, marches out in a close column numbering from a few hundreds to several thousands. The army is guided to its destination, which may be an hour's march distant, by several ants who run from side to side with heads down, evidently finding their way by scent. A marauding excursion of the *F. rufescens*, or Amazons, against the *F. rufibarbis*, a sub-species of the *F. fusca*, or small black ants, took place as follows: The vanguard of the robber army found that it had reached the neighborhood of the hostile nest more quickly than it had expected; for it halted suddenly and decidedly, and sent a number of messengers which brought up the main body and the rear-guard with incredible speed. In less than thirty seconds the whole army had closed up, and hurled itself in a mass on the dome of the hostile nest. This was the more necessary, as the *rufibarbes* during the short halt had discovered the approach of the enemy, and

had utilized the time to cover the dome with defenders. An indescribable struggle followed, but the superior numbers of the Amazons overcame, and they penetrated into the nest, while the defenders poured by thousands out of the same holes, with their larvæ and pupæ in their jaws, and escaped to the nearest plants and bushes, running over the heaps of their assailants. These looked on the matter as hopeless, and began to retreat. But the *rufibarbes*, furious at their proceedings, pursued them, and endeavored to get away from them the few pupæ they had obtained, by trying to seize the Amazons' legs and to snatch away the pupæ. The Amazon lets its jaws slip slowly along the captive pupa, as far as the head of its opponent, and pierces it, if it does not, as generally happens, draw back. But it often manages to seize the pupa at the instant at which the Amazon lets it go, and flees with it. This is managed the more easily when a comrade holds the robber by the legs, and compels it to loose its prey in order to guard itself against its assailant. The strength of the *rufibarbes* proved at last so great that the rear-guard of the retreating army was seriously pressed, and was obliged to give up its booty. A number of the Amazons also were overpowered and killed, but not without the *rufibarbes* also losing many people. Nevertheless, some individuals, as though desperate, rushed into the thickest hosts of the enemy, penetrated again into the nest, and carried off several pupæ by sheer audacity and skill. Ten minutes after the commencement of the retreat, all the Amazons had left the nest, and, being swifter than their opponents, they were only pursued for about half-way back. Their attack had failed on account of a short delay.

It seems to be a pretty general habit among many species of ants to dispose of the dead bodies of their comrades very carefully. The following especially notable account is given by an Australian observer:

"I saw a large number of ants surrounding the dead ones, and determined to watch their proceedings closely. I followed four or five that started off from the rest toward a hillock a short distance off, in which was an ants' nest. This they entered, and in about five minutes they reappeared, followed by others. All fell into rank, walking regularly and slowly two by two, until they arrived at the spot where lay the dead bodies of the soldier-ants. In a few minutes two of the ants advanced and took up the dead body of one of their comrades; then two others, and so on, until all were ready to march. First walked two ants bearing a body, then two without a burden; then two others with another dead ant, and so on, until the line was extended to about forty pairs, and the procession now moved slowly onward, followed by an irregular body of about two hundred ants. Occasionally the two laden ants stopped, and, laying down the dead ant, it was taken up by the two walking unburdened behind them, and thus, by occasionally relieving each other, they arrived at a sandy spot near the sea. The body of ants now commenced digging with their jaws a number of holes

in the ground, into each of which a dead ant was laid, where they now labored on until they had filled up the ants' graves. This did not quite finish the remarkable circumstances attending this funeral of the ants. Some six or seven of the ants had attempted to run off without performing their share of the task of digging; these were caught and brought back, when they were at once attacked by the body of ants and killed. A single grave was quickly dug, and they were all dropped into it."

A remarkable acquaintance with mechanical principles is shown by spiders in building and attaching their webs. This ingenuity is perhaps most strikingly shown in making the repairs that some accident has necessitated. A web had been broken from one of its attachments during a storm and flapped violently in the wind. The spider let itself down to the ground, and crawled to a place where lay some splintered pieces of a wooden fence thrown down by the storm. It fastened a thread to one of the bits of wood, turned back with it, and hung it to the lower part of its nest, about five feet from the ground. The performance was a wonderful one, for the weight of the wood sufficed to keep the nest tolerably firm, while it was yet light enough to yield to the wind, and so prevent further injury. The piece of wood was about two and a half inches long, and as thick as a goose-quill. On the following day a careless servant knocked her head against the wood and it fell down. But in the course of a few hours the spider had found it and brought it back to its place. When the storm ceased the spider mended her web, broke the supporting thread, and let the wood fall to the ground!

The following interesting observation on the intelligence of snakes shows, not only that these animals are well able to distinguish persons, but also that they possess an intensity of amiable emotion scarcely to be expected in this class. A writer to the London "Times" thus describes the behavior of some pet snakes kept by a gentleman and lady of his acquaintance:

"Mr. M——, after we had talked for a little time, asked if I had any fear of snakes; and after a timid 'No, not very,' from me, he produced out of a cupboard a large boa-constrictor, a python, and several small snakes, which at once made themselves at home on the writing-table among pens, ink, and books. I was at first a good deal startled, especially when the two large snakes coiled round and round my friend, and began to notice me with their bright eyes and forked tongues; but soon finding how tame they were, I ceased to feel frightened. After a short time Mr. M—— expressed a wish to call Mrs. M——, and left me with the boa deposited on an arm-chair. I felt a little queer when the animal began gradually to come near, but the entrance of my host and hostess, followed by two charming little children, put me at my ease again. After the first interchange of civilities, she and the children went at once to the boa, and, calling it by the most en-

dearing names, allowed it to twine itself most gracefully round about them. I sat talking for a long time, lost in wonder at the picture before me. Two beautiful little girls and their charming mother sat before me with a boa-constrictor (as thick as a small tree) twining playfully round the lady's waist and neck, and forming a kind of turban round her head, expecting to be petted and made much of like a kitten. The children, over and over again, took its head in their hands and kissed its mouth, pushing aside its forked tongue in doing so. The animal seemed much pleased, but kept turning its head continually toward me with a curious gaze, until I allowed it to nestle its head for a moment up my sleeve. Nothing could be prettier than to see this splendid serpent coiled all round Mrs. M—— while she moved about the room and when she stood to pour out our coffee. He seemed to adjust his weight so nicely, and every coil with its beautiful marking was relieved by the black velvet dress of the lady. It was long before I could make up my mind to end the visit."

Birds often show much ingenuity in attaining some desired end. Several stories are told of geese which show that they are by no means such scant-witted fowls as the common use of their name implies. Thus at Ardglass, county Down, Ireland, is a long tract of turf coming to the edge of the rocks overhanging the sea, where cattle and geese feed; at a barn on this tract there was a low inclosure, with a door fastening by a hook and staple to the side-post: when the hook was out of the staple the door fell open by its own weight. One day a goose with a large troop of goslings was seen coming off the turf to this door, which was secured by the hook being in the staple. The goose waited for a minute or two as if for the door to be opened, and then turned round as if to go away, but what she did was to make a rush at the door, and making a dart with her beak at the point of the hook nearly threw it out of the staple; she repeated this manœuvre, and succeeded at the third attempt, the door fell open, and the goose led her troop in with a sound of triumphant chuckling. How had the goose learned that the force of the rush was needful to give the hook a sufficient toss?

The intelligence of crows is well attested by the following account contributed by a lady: "In the inn-garden I saw a dog eating a piece of carrion in the presence of several of these covetous birds. They evidently said a great deal to each other on the subject, and now and then one or two of them tried to pull the meat away from him, which he resented. At last a big strong crow succeeded in tearing off a piece, with which he returned to the pine where the others were congregated, and after much earnest speech they all surrounded the dog, and the leading bird dexterously dropped the small piece of meat within reach of his mouth, when he immediately snapped at it, letting go the big piece unwisely for a second, on which two of the crows flew away with it to the pine, and with much fluttering and hilarity

they all ate, or rather gorged it, the deceived dog looking vacant and bewildered for a moment, after which he sat under the tree and barked at them inanely."

Crows have also been observed to hold general assemblies whose functions seem to be those of a criminal court. It often takes a day or two for the meeting to assemble; a palaver is then held, at the close of which the whole body sets upon two or three apparent culprits and kills them. No witness of such a scene can fail to be convinced that the accused have had a fair trial, and have not been put to death without cause.

The higher mental faculties are more developed in the elephant than in any other animal, except the dog and the monkey. The general fact that elephants are habitually employed in parts of India for storing timber, building, etc., shows a high level of docile intelligence. But perhaps in no labor in which they are employed do they display a more wonderful sagacity than in helping to catch wild elephants. A herd of wild elephants is driven into a corral, and two tame ones ridden in among them. The decoys will crowd up on either side of a wild one, and protect the nooser until a rope is fastened round the wild elephant's leg, when the tame one, to whose collar the other end of the rope is attached, will drag the captive out, and wind the rope round a tree, while the other decoy prevents any interference from the herd, and pushes the captive toward the tree, thus enabling the first one to take in the slack of the rope. The conduct of the tame ones during all these proceedings is truly wonderful. They display the most perfect conception of every movement, both of the object to be attained and of the means to accomplish it. On one occasion, in tying up a large elephant, he contrived, before he could be hauled close up to the tree, to walk once or twice round it, carrying the rope with him; the decoy, perceiving the advantage he had thus gained over the nooser, walked up of her own accord, and pushed him backward with her head, till she made him unwind himself again; upon which the rope was hauled tight and made fast.

One could almost fancy there was a display of dry humor in the manner in which the decoys thus play with the fears of the wild herd, and make light of their efforts at resistance. When reluctant they shove them forward, when violent they drive them back; when the wild ones throw themselves down, the tame ones butt them with head and shoulders and force them up again; and, when it is necessary to keep them down, they kneel upon them, and prevent them from rising, till the ropes are secured.

A remarkable degree of cunning was displayed by an elephant who had been chained to a tree, and whose driver had then made an oven at a short distance, into which he put some rice-cakes to bake. The man covered his cakes with stones and grass, and went away. When he was gone, the elephant with his trunk unfastened the chain round

his foot, went to the oven and uncovered it, took out and ate the cakes, re-covered the oven with the stones and grass as before, and went back to his place. He could not fasten the chain again round his own foot, so he twisted it round and round it, in order to look the same, and when the driver returned the elephant was standing with his back to the oven. The driver went for his cakes, discovered the theft, and, looking round, caught the elephant's eye as he looked back over his shoulder out of the corner of it. Instantly he detected the culprit, and condign punishment followed.

The well-known intelligence of the dog is seldom more curiously manifested than in the cases of those who learn the use of money. A gentleman in Birmingham was acquainted with a small mongrel dog who, on being presented with a penny or a half-penny, would run with it in his mouth to a baker's, jump on to the top of the half-door leading into the shop, and ring the bell behind the door until the baker came forward and gave him a bun or a biscuit in exchange for the coin. The dog would accept any small biscuit for a half-penny, but nothing less than a bun would satisfy him for a penny. On one occasion the baker (being annoyed at the dog's too frequent visits), after receiving the coin, refused to give the dog anything in exchange, and on every future occasion the latter (who declined being *taken in* a second time) would put the coin on the floor, and not permit the baker to pick it up until he had received its equivalent.

In what may be called the chief pursuit of dogs—that of game—they often show great ingenuity in overcoming unusual obstacles. A little Skye terrier was once observed snuffing about on a wheat-stack which was in the course of being thrashed, when suddenly a very large rat bounced off, just from under her nose. It darted into a pit of water about a dozen yards from the stack, and tried to escape. The Skye, however, plunged after, and swam for some distance, but found she was being left behind. So she turned to the shore again, and ran round to the other side of the pit, and was ready and caught it just on landing.

Another dog, which had been sent to bring in a couple of wounded ducks from across a pretty wide stream, at first attempted to bring them both, but one always struggled out of his mouth; he then laid down one, intending to bring the other, but, whenever he attempted to cross, the bird left fluttered into the water; he immediately returned again, laid down the first on the shore, and recovered the other. The first now fluttered away, but he instantly secured it, and, standing over them both, seemed to cogitate for a moment; then, although on any other occasion he never ruffled a feather, he deliberately killed one, brought over the other, and then returned for the dead bird.

An instance of sagacity—indeed, amounting to reason—in a French poodle is told by Canon ——. Being a guest at luncheon with the dog's master, the canon fed the dog with pieces of beef. After lunch-

eon the beef was taken into the larder. The dog did not think he had his fair share. What did he do? Now, he had been taught to stand on his hind-legs, put his paw on a lady's wrist, and hand her into the dining-room. He adopted the same tactics with the canon, stood on his hind-legs, put his paw on his arm, and made for the door. To see what would follow, Canon —— suffered himself to be led, but the sagacious dog, instead of steering for the dining-room, led him in the direction of the larder, along a passage, down steps, etc., and did not halt till he brought him to the larder, and close to the shelf where the beef had been put. The dog had a small bit given him for his sagacity, and Canon —— returned to the drawing-room. But the dog was still not satisfied. He tried the same trick again, but this time fruitlessly. The canon was not going again with him to the larder. What was Mori to do? And here comes the instance of reason in the poodle: Finding he could not prevail on the visitor to make a second excursion to the larder, he went out into the hall, took in his teeth the canon's hat from off the hall-table, and carried it under the shelf in the larder where the coveted beef lay out of his reach. There he was found, waiting for the owner of the hat, and expecting another savory bit when he should come for it.

CHEMISTRY AND PHARMACY.*

By Professor IRA REMSEN.

CHEMISTRY owes a debt of gratitude to Pharmacy which she has for years been striving to repay. And when a disciple of the new science is called upon to address those who stand at the threshold of a career which will bind them to the old art, his thoughts naturally turn to the day when the occupations of the chemist and the pharmacist were united in one person—when all that was worth knowing of chemistry was mastered by the pharmacist, and the art of pharmacy was practiced by the chemist. We are far removed from that day now. Both the subjects once so intimately associated have developed to an enormous extent, and he would be a brave person who would attempt to make himself master of the lore of both pharmacy and chemistry. The term "chemist" has come to have a signification quite different from that which it once had, though it is used now, as of old, in two entirely distinct senses. There is, first, the chemist who makes use of facts already established for a variety of useful purposes, some of them of the greatest value to the human race. Such a one practices the *art of chemistry*. Then there is, in the second place, the chemist

* An address delivered in the Academy of Music, Baltimore, before the graduating class of the Maryland College of Pharmacy.

who establishes the facts which are to be made use of. He spends his time in delving in out-of-the-way corners, turning over this and that, and endeavoring to get at the principles which underlie what is called chemical action. Such a one is following the *science of chemistry*. Now you, gentlemen, are primarily chemists in the first sense—you are to practice to a limited extent the art of chemistry.

It has seemed to me that, during the short time to be devoted to my remarks, it might be both interesting and profitable to examine into the questions: What has Chemistry to thank Pharmacy for? and what has Pharmacy to thank Chemistry for?

As regards the former question, it may be answered that, in the first place, the desire to discover new substances for medical purposes originally formed a strong incentive to those engaged in chemical work, and undoubtedly a large number of valuable observations have been made by those who were working primarily to gain possession of substances which might be valuable to pharmacy. We know that the collection and the manufacture of drugs of many forms is one of the most ancient of occupations, and it seems to have been regarded as a very important one, as all who have ever been afflicted with the ills that flesh is heir to (and who has not?) can easily appreciate. The alleviation of human suffering is a high object to strive for, and for this purpose the physician and pharmacist join hand to hand, and they had been working together for long ages before chemistry and chemists were ever heard of. While gaining experience which proved of direct value to them in their professions, they were also, though unconsciously, doing something toward laying the foundations of a science which has since been developed. They were helping to collect the material, the accurate scientific study of which was undertaken at a later date. Finally, there came the time when men began to study some of the substances which they gained possession of, with no other purpose in view than to learn something more with reference to their general properties, and their conduct under different circumstances. When that time came, the science of chemistry was born.

Again, in addition to the collection of much of the material which formed the basis of the first chemical study, indeed, as a consequence of this, we find that during a considerable period—from the middle of the seventeenth century—many of those who achieved the greatest distinction in chemical work were those who began as pharmacists. Among the earliest of these may be mentioned Kunkel, the discoverer of phosphorus; Lemery, author of one of the most valuable of the text-books of chemistry; Geoffroy, whose investigations on chemical affinity were of such great importance to chemistry; Marggraf, the discoverer of alumina and of the composition of gypsum; Scheele, the great discoverer of oxygen and of chlorine; in France, Lefêvre, Glaser, and others; and, finally, more recently, the most influential chemist of modern times, the great German, Liebig.

For a long time the only chemical laboratories known were the pharmacies, and of course all chemical work was then done by the pharmacists. If any one desired a knowledge of chemistry, his only way to acquire it was to enter a pharmacy, and this whether he desired to practice the art or not. It was not until between the twentieth and thirtieth year of the present century that there existed any laboratory in which a student could acquire a special knowledge of chemistry.

In another way we see the intimate connection which but a short time ago existed between chemistry and pharmacy. The principal chemical journal of the world, which was started in the year 1832 by Liebig, was called during a period of forty years the "Annals of Chemistry and Pharmacy," and only about ten years ago was its name changed to the "Annals of Chemistry"; and many other publications might be mentioned whose titles give clear indications of the close relationship existing between the two subjects.

The fact is, the interests of chemistry and pharmacy were identical during the period to which I have referred. What helped the one helped the other. But, beginning as a partial offspring of pharmacy, chemistry has attained to a position of great importance in the world, and has become gradually the foundation of more than one occupation. To-day not only pharmacists, but those of many other professions, have to look to chemistry for that knowledge of substances and of kinds of action which is necessary for their success. An extended examination of the subject would show us that pharmacy played a very important part in the founding, particularly of that field of chemistry which is usually designated by the name "organic chemistry"—a field in which many of the brilliant modern victories of chemists have been achieved. Without the fundamental work of pharmacists in extracting from plants their valuable constituents, organic chemistry would to-day be in its infancy, instead of being what it is—a giant of mighty strength, exerting a controlling influence upon a number of important occupations, including pharmacy. But what this subject is to-day is only a promise of what it is to be when the results, which we now see plainly foreshadowed, shall have been accomplished. I think it is clear, then, that Chemistry has much to thank Pharmacy for; but what has Chemistry done toward paying the debt she owes? Much, very much, directly and indirectly. It is impossible to enter into details this evening. I can only refer to a few features which seem to me worthy of special notice.

The accurate scientific study of chemical substances, whether these are of use to pharmacy or not, has led to the introduction of more accurate methods in pharmacy. The extraction and preparation of medicinal compounds were at first very crude and simple operations. These were gradually improved upon, of course, as time passed on, but they were only perfected when the science of chemistry began to exert its influence. The point to be particularly observed here is this,

that it is rather the study of chemical action than the particular study of this or that substance as such that tends to improve the method of work. In this way many obscure substances have contributed largely to the improvement of chemistry, and consequently to the improvement of pharmacy. There is a not uncommon feeling that it is a waste of time to work for years endeavoring to unravel the secrets of some apparently insignificant substance. If the substance itself can not be used, and there is no prospect that it ever can be used, then, it is argued, it can not be important. To you, gentlemen, who have been under especially good instruction in these matters, this argument will not appear to be of much weight, but permit me to turn my attention for a moment to the larger audience before us, and to say a word in defense of those who spend their lives in what are commonly looked upon as unprofitable investigations.

Not long ago I heard this story, which may serve as a sort of overture to what I want to say: An excellent gentleman, on being informed that a certain scientific man was engaged in work upon frogs, replied, "Why spend his time in such trivial work, when there is the human soul to investigate?" The feeling which actuated the speaker is one which I repeat is not uncommon, and I may add it is quite natural, but it is certainly wrong in principle. If we analyze the underlying thought of those who cavil at ordinary scientific investigation, we shall find that there are two distinct ideas contained in it: First, that, in order that any investigation shall be of value or of importance, it must bear direct fruit. The substance discovered must be useful for some "practical" purpose, either as a medicine or as a dyestuff, an explosive or a poison—no matter what, so that it can be used for something. A second idea is that, in order to solve the problems of nature, only those of the most evident importance should be attacked. Such questions as What is life? What is electricity? What is the attraction of gravitation? What is force? What is matter?—these are the ones which, in the opinion of many, should occupy investigators, to the exclusion of the less important.

As regards the latter idea, it may be said that there are a great many very strongly fortified citadels in nature. Scientific investigators have attacked these from time to time and have been repulsed. A good commander, having discovered that a stronghold is invulnerable from a given point, does not continue to attempt its capture from that side, but looks around him for other means of approach; he strengthens his forces, he collects more ammunition, and endeavors to keep his army in general in good condition, studying the surrounding country, and awaiting new revelations. There is, further, a great deal of insignificant camp-work to be done, and, if this is neglected, ultimate success can not be hoped for.

So, too, the scientific investigator finding that a certain problem of paramount importance can not be solved, turns his attention to

others, the solution of which may in the end contribute to clearing up greater mysteries. There are hosts of minor questions to be answered, and these must be answered before the fundamental questions of nature can be. Through the insignificant lie the roads of advancement. A fallen leaf, a bit of stone, a tiny flower, a microscopic animal, may contain within themselves the answers to the most important questions. It is not the leaf, or the stone, or the animal that is specially investigated, but the principles involved in their existence. Explain these, if possible, and the explanations will serve for a thousand other things. Then, too, though the explanations sought for may not be found, the correct study of any fact or phenomenon of nature is of assistance to science as a whole. It strengthens her forces, it supplies her with ammunition. An enormous amount of camp-work must be done, or results of value can not be attained. Let the work upon the insignificant problems cease, and the world would sink into darkness. To fully understand the laws of the universe as a whole, we must first learn all we can in regard to the smallest subdivisions of the universe —the atoms.

As regards the idea that an investigation must bear direct fruit to be valuable, I would say that the reply to this is contained partly in what I have already said, but it can be refuted much more clearly and appropriately for our present purpose by the consideration of an example or two. As I remarked a few minutes since, when a new substance is discovered by a chemist, the first question asked by most persons is, What is it good for? what can it be used for? As I desire to show that pharmacy is much indebted to chemistry in recent times, it would seem that I ought first to show that many new substances have been discovered by chemists which are of use in pharmacy. This is, however, so obvious that I prefer to show how some of the most abstruse chemical investigations may ultimately yield fruit of much value to pharmacy. In an address which I had the honor to deliver a few years ago in this building, before the "Medical and Chirurgical Faculty of Maryland," I referred to the purely scientific investigations which led to the discovery of choral, and to a method for the manufacture of salicylic acid on the large scale. It can easily be shown that these discoveries were made, not because the discoverers were attempting to find substances gifted with the properties which these two are known to possess, but that they were made as the result of abstruse chemical investigation, undertaken simply with the object of adding to the possessions of science. I shall not repeat what I then said, for there are enough new examples, as well as old, to furnish us with interesting material.

Of comparatively recent discoveries, which may be classed among those which are of direct importance to pharmacy, is that of the artificial preparation of the oil of mustard. This substance is now made by a patented process entirely independently of the mustard-plant. I

do not know that the artificial method can at present compete with the natural, but it will probably do so before long, if it does not now. Little did the discoverer dream of the result when he undertook his investigation. When glycerin and oxalic acid are mixed, and the mixture distilled, the chief product under ordinary circumstances is formic acid, a substance found in nature in the bodies of certain ants. Formic acid had been made by the method mentioned for a number of years before it was noticed that something else is formed at the same time. This observation was made about the year 1870, by Tollens, in a chemical factory. On looking into the matter more closely, it was found that the second substance is allyl alcohol, already well known. Now this allyl alcohol is closely related to the oil of mustard, but, up to the year 1870, no method was known by which it could be prepared easily and in large quantity. Now it can be made, thanks to the investigation of Tollens, in any desired quantity. Its transformation into the oil of mustard is a comparatively simple matter, and thus starting from the two common substances, glycerin and oxalic acid, it is now practical to pass to the valuable oil of mustard. You will observe that, in this case, the object of the discoverer of the method was not to get the oil of mustard, but simply to learn what else could be formed besides formic acid under the conditions above mentioned. The question which he proposed to answer was not a very elevated one, nor one the answering of which was at all likely to lead to results of practical value; but, nevertheless, a valuable result did follow.

At the present time there are several chemists engaged on investigations which promise eventually to be of the highest value to pharmacy. Let me attempt to give you some idea of these. For a long time it has been known that from many plants there can be extracted certain constituents which seem to concentrate the medicinal properties of the plants themselves. They form what are sometimes called the active principles of the plants. They are also, and more commonly, known as the alkaloids. Thus, from the white poppy cultivated in Asia Minor, Egypt, Hindostan, and elsewhere, is extracted opium, which in turn contains a number of alkaloids, as morphine, codeine, narcotine, etc.; from Peruvian bark are obtained the valuable alkaloids quinine, cinchonine, etc.; from the St. Ignatius bean comes strychnine; from tobacco, nicotine; from coffee, caffeine, etc. The great value of many of these alkaloids, especially of morphine and quinine for medicinal purposes, has, as we all know, long been recognized. They have, however, been but little understood by chemists, and this has been a just reproach to chemistry. They have been studied carefully, better and better methods have been devised for their extraction and purification, but scarcely anything has been done until within a year or two past to clear up their inner nature. Their relations to simple substances were not known, and it seemed quite

impossible to conceive of any method by which our knowledge concerning them could be materially enlarged. Recently, however, a change has come over the scene, and now, in consequence of a very simple scientific observation, a large number of chemists have turned their attention to this field, and it looks as though the time is not far distant when the chemist will be able to produce artificially in the laboratory the alkaloids for which we have hitherto been entirely dependent upon nature. How did this come about? By carrying on investigations on insignificant substances, simply for scientific purposes, to learn more regarding these substances for the sake of increasing our knowledge.

In the year 1851 Anderson, a Scotch chemist, undertook the examination of the oil which is formed when bones are heated. We all know the extremely disagreeable properties of this oil. Its odor would be enough to prevent any but a bold man from undertaking its examination. It is a very complex substance also, and, at first, it seems almost impossible to get from it pure and definite substances. Anderson, recognizing the difficulties before him, went at the problem in a large way. He distilled about two hundred and fifty gallons, or more than a ton, of the disgusting bone-oil, and repeated this operation over and over again. He was finally rewarded by the discovery of some curious substances which he called pyridine, picoline, and lutidine. These substances have from time to time been met with since, but they have played a very subordinate part in chemistry until very recently. About two years ago a young chemist (and, as chance would have it, again a Scotchman) tried an experiment which gave him the startling result that from quinine there can easily be obtained a substance closely related to the pyridine of Anderson; and, indeed, by a further step pyridine itself was obtained. This gave the first hint as to the chemical nature of quinine, and chemists at once recognized the importance of the discovery. Immediately great activity showed itself in the further examination of bone-oil or animal-tar, and our knowledge of this substance was rapidly increased. At the same time it has been shown that not only quinine, but many other alkaloids, are related to pyridine and the other substances discovered by Anderson thirty years ago. Every month we receive reports of rapid advances, and it looks, indeed, as though we should not have long to wait before we hear it announced that quinine and morphine, and perhaps a host of other valuable alkaloids, have been made from the offensive oil which is given off when bones are heated. In view of many past achievements I do not think that this is too much to expect. Look at the unpromising coal-tar, at one time the bugbear of gas-manufacturers! It has become the source of many of the most valuable and interesting chemical substances. Nothing could less suggest the beautiful dye-stuffs, the delicious essences, which can be and are obtained from it in quantity. Surely, with the knowledge already in our possession we have a right

to look forward to as brilliant a future for animal-tar as has been the past and is the present of coal-tar. Both substances, offensive as they are, are necessarily prepared in large quantities. The coal-tar is a result of the manufacture of gas; the animal-tar is produced in the manufacture of bone-black or animal-charcoal, which is used to such an enormous extent for the purification of sugar. Had it not been for the untiring and unselfish labors of scores of scientific investigators, who worked for no other object than to increase knowledge for the sake of knowledge, we would to-day be in ignorance of the beautiful and valuable possibilities of these two unattractive substances.

I might multiply examples indefinitely, but the time at my disposal is limited. I have endeavored to show, gentlemen, that while Pharmacy did a great deal to build up the science of Chemistry, Chemistry in her turn, when she reached maturity, began to pay back the debt she owed and pay it back with interest. It is to the science of Chemistry that Pharmacy must look for future advancement, and even the most obscure and most unintelligible of the many chemical investigations which are being carried on at present may eventually prove to be important steps in some line of reasoning which will have the enriching of pharmacy as its result. Nothing in science is too insignificant for notice. We can not tell what the simplest observation may lead to, and it behooves every one whose daily occupation brings him in contact with chemical substances to be ever on the alert and, in true scientific spirit, to follow up, independently of any direct practical result, the slightest observations. Many of you, gentlemen, will have the opportunity to add materially to human knowledge. You will have laboratories at your disposal, and you have been well instructed in chemistry. If you have the desire, you may do much to help your profession. Your chances of success will be better, if you keep yourselves interested in the scientific as well as in the purely practical side of your calling. There is enough work to be done. In certain directions chemistry has only just begun to advance, and there are vast regions still entirely unexplored. Many an arctic sea of chemistry, with its fascinating north pole, awaits the first expedition. An eminent mathematician once said that a new problem in mathematics might easily be furnished for every man, woman, and child in this vast country, and there would then be plenty left for foreigners. A similar remark might be made concerning chemistry. As I have, then, attempted to show that you must look to science for the advance of your calling, I desire above all to leave upon your minds the impression that each of you, if you will, can do something for the common cause. If, in after-years, it shall be my privilege to hear that one among you has really been led to enrich the domains of science, I shall look back upon my part in this evening's proceedings with feelings of great satisfaction.

POSITION AND STROKE IN SWIMMING.

By RICHARD LAMB, C. E.

PERHAPS there has been no science—at least none of equal importance—that has been less developed theoretically than swimming. The essay of Franklin upon the subject, although an answer to the inquiry of "how to swim," is merely an article with advice as to when and how long to bathe, and the narration of anecdotes of his experience in swimming. In the literature of the subject we fail to find any practical directions that could assist a novice in learning to swim; for this reason we propose briefly to analyze one or two important points, which, if put into practice, will make it an easy matter to acquire the art.

It has been the writer's experience, in teaching beginners, that the great difficulty lies, not in the inability on the part of the scholars to master the correct stroke, but in the fact that while using the correct stroke, for a certain reason, they find it difficult to keep their heads above water. Some of the scholars did not lack in determination or bravery, and yet their efforts were fruitless. They would apply the correct stroke with great force, and yet eventually their heads would sink. Finally, the complaint of one of the scholars, to the effect that the effort seemed to tire the neck more than any other part of the body, led to a contemplation of the cause of the fact.

While investigating the facts in the case, it was observed that a beginner throws himself upon the water in a stiff and straight position, not allowing the body or back to bend at all, but merely bending the neck. He kicks his legs in a vertical direction, tending to raise the back to the surface of the water, and thus places himself in a position parallel to the line of the surface. It is easily seen that he must bend his neck nearly perpendicular to this line of direction in order to keep his head above water (see Fig. 1). We have merely to try this

FIG. 1.

position on land, to experience its difficulty and disagreeableness. The muscles of the throat are greatly strained, while the air-tube is nearly closed, causing difficult respiration.

It is not to be wondered at that the learner soon relaxes this unnatural position of the head, and gives up the effort to keep his face

above water. But, when the correct position is once mastered, this difficulty disappears, and swimming is made as natural and easy a function of the body as running or walking.

Fig. 2, showing the correct position of the body while swimming, has been drawn from empirical analysis, and is as plausible in theory as in practice. All of the propulsory exertions should be given so as to have but one tendency—that of advancing the body directly forward. (The proper method for accomplishing this end will be spoken of further on.) Now, admitting that the whole tendency of the stroke is to force the body in the direction of the component, *c*, if the body be so bent that the chest and part of the abdomen will form a resistance, making an angle with the direction of the force—as *a*, *b*, *c*—the tendency of that resistance will be to form a resultant in the direction

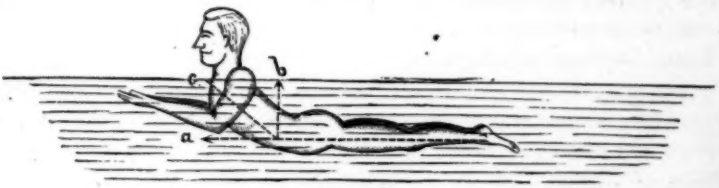


Fig. 2.

of *b*, which forms, with the natural buoyancy of the body, the force that keeps the head above water.

A concomitant advantage in the position under discussion is, that the neck and head are free to take their natural positions, and hence the avoidance of the evil referred to in speaking of the position of the head assumed by beginners.

The greatest difficulty to the beginner is to learn to keep the proper position of the body after attaining it. This difficulty can only be overcome by using the proper stroke after having placed the body in the correct position.

In the use of the arms, the only direction that can be given is to remember that, when the arms are thrust forward at the beginning of the stroke, such position of the elbows and hands should be taken as will make the least resistance to the water. To accomplish this, the hands should be placed palm to palm, and the elbows made to come quite close together, starting them from under the chest, as in the cut. In making the effective part of the stroke, our object is to get a forward motion only. The arms and hands should be so placed as to produce the greatest resistance upon the water. To accomplish this, the palms of the hands should be thrown outward, and the plane of the direction of the stroke of the arms made parallel to the surface of the water.

The most important and the most often defective point in swimming is the mode of using the legs. It would be well for a beginner to observe the swimming of a frog, for undoubtedly the same method

of using the legs should be adopted by man as is displayed in the model swimming of that amphibian.

In analyzing the stroke of the frog, we notice that there is no vertical motion; the whole direction of the force is in a plane exactly horizontal, and is accomplished by virtually opening and closing the space between the knees—offering the sole of the foot as a resistance while kicking, and placing the feet in a position of least resistance while recovering.

In accomplishing the first of these conditions—the opening and closing of the space between the knees—the knees should be thrown out, and the contraction of the legs made slowly, in order to cause as little resistance as possible to the headway already attained.

It will be found that, if we alternate the stroke of the arms and legs by giving propulsion with one while recovering with the other, a more constant buoyancy will be attained, and, for long swims, it will be found far less fatiguing.

HOW THE ANCIENT FORESTS BECAME COAL.*

By M. G. De SAPORTA.

THE carboniferous formation represents the most wonderful episode in the history of our globe. It gives us an impression comparable in strangeness to that produced by those wonderful civilizations which blossomed out so suddenly and so splendidly in the infancy of mankind. Only a rare concurrence of circumstances could have brought on the expansion of plant-growth which characterized its epoch. The world of plants was still young and imperfect. Vegetation was characterized by the abundance of green parts susceptible of rapid growth, and of an almost indefinite development. It was, however, destitute of two characters which have been acquired by the later plants: those of the periodical and gradual increase of parts destined to endure, and of an absolute specialization of the reproductive apparatus. The vegetable kingdom was the first factor in the production of coal, but not the only one; and two other factors must be taken into account in studying its genesis. One of these related to the conditions of the environment, the climate, and the temperature; the other to the situations in which the plants that were converted into coal were placed. Had either of these conditions been essentially different or left out, we would have had no coal. The influence of situation is shown by the fact that the coal-beds are always intermittent; that they are limited in extent, and pass laterally into shales

* Translated and condensed for "The Popular Science Monthly" from the "Revue des Deux Mondes."

and sandstones, so as to show that there was nothing universal in the phenomenon, and that it was liable to interruption by physical changes. It is also easy to conceive that the formation of coal could not have gone on unless the vegetation was adapted to the process, and the conditions of the climate were suitable. The coal-plants could never have grown and flourished as they did in the present climates of the North; and our hard-wood trees, with their firm foundations in the ground, and their slow, periodical growth, could never by decaying in the open air have produced the peculiar and rich combinations we find in the coal-beds. The nature and bearing of these three concurrent factors have been carefully studied out by M. L. Grand' Eury, who has for that purpose spent many years in personal inspection of various mines and their surroundings, and has presented, in his "Mémoire sur la formation de la houille" ("Memoir on the Formation of Coal," Paris, 1882), a complete theory on the subject, including a review of the details of the process as taught by his observations of the phenomena.

The plants of the coal-measures, so far as their nature has been revealed to us by their remains, were great ferns, gigantic lycopodiums, called by the geologists lepidodendrons, and calamites and asterophyllites, allied to existing *Equisetaceæ;* all referable to the class of cryptogams. Besides these was another group, the character of which was long problematical, composed of the sigillarias and stigmarias. It now appears to be established that the stigmarias were a kind of rhizoma which had the faculty of persisting for a long time under the mud unchanged, growing and multiplying by stolons, but incapable in that condition of producing sexual organs; while under favorable circumstances they formed enormous buds whence shot up to the height of a hundred or a hundred and fifty feet the huge leaf-clad stems whose fossils, marked with the beautiful scars representing the leaf-attachments, have been called sigillarias. Gymnosperms were also quite plentiful, of one class of which, the cordaites, M. Grand' Eury has made some happy restorations. He has found their leaves and seeds in considerable abundance at Saint-Étienne, and he has observed at the same place visible traces of their carbonized trunks, still standing erect and traversing the sandstone strata of some of the quarries.

A peculiar feature of these plants was the extraordinary predominance of the cellular or succulent tissues in them, and the corresponding rarity of the hard or fibro-ligneous parts, which appear reduced to insignificant cylinders. It was certainly not the destiny of these parts to increase with time, after the manner of the wood of our trees; and, in examining the mature stems of the ancient plants, we never find any more than an extremely thin ring of real wood. The rest is all pith, and even the bark, except on the outside, frequently presents an open or spongy texture. Such structure is similar to that of the aquatic plants of the present time, which can not exist at all in the air, and wither as soon as they are taken out of the water. An atmos-

phere saturated with moisture was therefore essential to their vigor; and in such an atmosphere, according to M. Grand' Eury, they grew continually, without interruption by changes of season, without rest or alternations, to exhaustion; then to fall to the ground, and give place to other similar growths. So luxuriant a vegetation could only have been produced by the combination of an ultra-tropical heat with an excessive humidity, under no other changes of seasons than those distinguished by intervals of relative calm and of torrential rains. At the same time, the superabundance of green parts, which characterized even the trunks of the trees, presupposes a considerable intensity of light; and all the phenomena point to a strong diffused light, the direct rays of the sun being tempered by the interposed veil of vapors, as that under the influence of which these growths were produced.

The third element of the problem, that of the material disposition of the places in which the coal was formed, is the one that has offered the most difficulties. Two theories have been held on this subject. One is, that the materials were carried by ocean-currents or rivers from considerable distances to the places of deposit. Naturalists, however, who have applied themselves specially to the study of the carboniferous flora, have not been able to reconcile the orderly arrangement of the fragments, in which the specimens are so delicately posed, mingled without confusion, and often distributed uniformly in collections of leaves of the same species, with the confused drifts which are the almost invariable results of such a method of transportation. Moreover, in all coal-regions, recognizable trunks of calamites, tree-ferns, sigillarias, and other types of the carboniferous flora are found in the neighborhood of the coal, vertically crossing the strata of sandstone that accompany and separate the coal-beds in such a manner as to show that they grew over the ground of the whole region, and to indicate that their transformation was dependent upon some special or local phenomenon which may have been quite simple, or at least natural, and were probably resultant from the physical conditions of the land at that epoch. The other theory, that coal originated in the decomposition of trees and plants that grew on the spot, is insufficient to account for all the phenomena and circumstances, and raises new difficulties.

M. Grand' Eury, in whose theory transportation, but of a different character from that presumed in the first of these two theories, forms an important element, has been enabled, through his investigations at Saint-Étienne, to form a clear idea of the nature of coal and the processes to which we owe it, and also to enter into the details of the matter, to go back to the true causes of the processes, and to describe with remarkable precision how they must have taken place. The land of the carboniferous formations appears, after an intelligent examination of the stratigraphy, to have been frequently covered by the sea, and therefore in its immediate neighborhood. The coal-beds themselves were

an essentially terrestrial formation, peculiar to the recently emerged land of the period. In Belgium and England they rest upon a marine deposit, which forms their floor, and which reappears in the course of the formation, alternating several times with the strata of land-growth. We learn from this that the sea was retiring from these spots before the extension of the continental area, leaving a broader strip of land after each fitful inundation, and that the carboniferous vegetation was developed on the ground which the marine waters had just abandoned. This phenomenon acquires great force with its frequent recurrence and repetition in various places.

None of the carboniferous plants except the stigmarias, whose peculiarities we have noticed, appear to have been especially aquatic; but they could all endure the immediate neighborhood and occasional contact of water without being hurt by it, and could live and grow, even when partially inundated. They grew around the borders and on the slopes of the lagoons with which the shore was studded, the smaller ones thickly matted under the cover of the larger trees, in groups characterized by the predominance of single species, as is shown by the distribution of the fossils. The coal was deposited in the lacustrine beds at the center of these forest-covered depressions; and the extent of the deposits is measured by the area of the basins that were fitted to receive them. One condition was essential, without which no seam of combustible matter could have been formed. It was, that the water flowing over the ground should bring with it and leave in the bottom of the basin where the carboniferous matter was destined to accumulate, only the remains of plants, to the exclusion of every other form of sediment. This condition may have been more easily realized in the Carboniferous epoch than at any other time, because the flora was more abundant and its extension more favored by the climate. It is conceivable also that, after having been once established, it might have been liable to interruption at any time; for a slight oscillation of the ground, a change in the direction of the currents, the washing down of a bluff, or the removal of some impediment, may have been enough to furnish an opportunity for the introduction of sand, mud, or rock-dust, into the deposits. We may also affirm as essential that there should be no real affluent coming down to the place of deposit, or current of running water, for that would bring down mud, and leave in the bed some other sediment than one of coal. The flow of water must have been a gentle trickling over the soil, bathing it without washing it, but strong enough to carry along the vegetable matter which it finally deposited. Whenever the flow became more violent, the formation of coal was interrupted to give place to deposits of shale or sandstone, according to the character of the mineral elements brought down, or, if they were in relatively small proportion to the vegetable fragments, of schistose laminæ marked with impressions of plants.

Such formations are of frequent occurrence in the coal-measures, in alternation with the seams of coal and the marine deposits left by the overflow of the sea, and this was doubtless their origin. The fossil forests which have been discovered in the same regions may be similarly accounted for. The trees growing around the perimeters of the lagoons would be partially submerged by the overflowing water, and the sections of them buried in its muddy deposit would be left to decay and fossilize in it. The persistent root-stocks of the sigillarias and calamites, unharmed by the flood, would send up new aërial stems; and most of the other plants, having the power of sending out adventitious roots from their trunks, would be able to live and continue to grow by that means, leaving their old lower parts to die, while they lifted themselves, as it were, bodily up with the ascensional movement of the soil. Several examples of such successive emissions of roots are figured in the "Mémoire." M. Grand' Eury has assumed that the concurrence of two principal circumstances, acting coincidently and in combination with each other, contributed essentially to the formation of coal. One was the transportation by water for short distances of all the vegetable matter of a region to be spread out flat and stratified at the bottom of the lagoon destined to receive it; the other was the exposure of the matter, previous to this process, in the open air to a certain amount of decay, of the nature and effects of which he has made a patient analysis. From these principles he has deduced a theory which may be summarized thus: The water which served as the vehicle for the vegetable matter, which must have been perfectly clean, because it was free from all mud, strong enough to carry along its drift, and plentiful enough to sweep all the points of the wooded region, could not have been any other than rain-water shed upon slopes pronounced enough to make it easy for it to run and carry the vegetable residues along with it, yet level enough not to allow the ground to be cut up. The land over which the water flowed must have been covered with a mass of plants and accumulated fragments abundant enough to furnish much flotsam matter, and matted enough to prevent its eroding the subjacent soil. The water must have been intermittent, else the fallen trunks of trees and the fragments of every kind which lay scattered over the ground would not have had time to undergo the partial decomposition and disaggregation of their tissues which necessarily preceded complete submersion. There must have been, then, if not real seasons, intervals of relative calm, in which the decomposition could have taken place, to be succeeded by times of protracted and extremely violent precipitation. The fact that a transportation and deposition of the parts took place is attested by the stratified structure of the coal. In both the coal and the schisto-carbonaceous laminæ, all of the fragments, down to the most delicate isolated organs, are always, with only the rarest exceptions, spread out flat, and cemented one over another, lying together like the leaves of

a book. A close examination of coal and its texture under the microscope will show that only water could have taken all the fragments of such different sizes and consistencies and arranged them in this way. The disposition is the same as is always shown when leaves and fragments of plants, having become thoroughly soaked, sink and form stratifications at the bottom of ponds. In the coal, the elements continue visible, and their arrangement in superposed laminæ is evident, while the interstices between the planes of junction appear to have been filled up in the course of the formation of the beds. These facts, with the perfect condition of the organization of many of the fragments; their agglomeration in an amorphous pulp, the resultant of the previous maceration of a host of fragments; and the reduction of the whole mass by compression to half of its primitive thickness—all parts of one and the same phenomenon—point to the action and weight of the bed of water at the bottom of which the stratification took place. The perfect uniformity which reigned over the formation of coal has given it generally a schistous structure, in thin leaves disposed in a parallel fashion and fissile in the direction of the plane of deposition. It is also found, on attentive examination, to be somewhat varied in constituency, according to the varying character of the elements of which it is composed, and the different stages of freshness and maturity in which they were deposited. One kind, which M. Grand' Eury calls "fusaine," from its resemblance to a stick-charcoal, comes from the decomposition of stems from which the anatomical structure has disappeared while they preserve their form. The green parts appear as crystalline laminæ, or scales, or black particles in the amorphous mass. This mass, the result of the maceration of wholly decomposed particles, constitutes the amorphous coal in which, besides "fusaine," we can always discover some remains of vegetable structure testifying to the common origin of all the coal products. Within these differences of type are innumerable variations passing from one to another, the existence of which prevents our establishing a clear distinction between the coals most homogeneous in appearance and those which show the multifarious and manifest traces of hardly altered organized elements.

M. Grand' Eury's sketches introduce us to the depths of the carboniferous forests, into regions of dense moisture, at the feet of gentle slopes where are accumulating in stagnant ponds immense drifts of the remains of constantly active, exuberant, and quickly exhausted vegetation. Masses of this kind may even now be observed in the midst of the virgin forests of hot countries; how much more might we have expected to find them in ancient epochs, when the trees made no wood, but sent up spontaneous, ungainly shoots, sudden growths in green columns, the function of which was as ephemeral as their texture was weak! Most of the carboniferous stems, hollow or filled with pith only, fell by the sheer exaggeration of their growth; the tree-ferns

were crowned with fronds of marvelous dimensions; the stems of the sigillarias shed their leaves rapidly; and the remains of all these rank growths were incessantly accumulating in a sultry shade on a water-soaked soil. We can conceive the enormous production of humus. Decomposition was accelerated by every rain, and the whole mass was reduced, down to the very bottom, to a black pulp; and this is why, notwithstanding we have such abundant materials, we meet so many difficulties in reconstructing the types. The fallen trunks seldom remained whole, but swelled and burst. The soft and porous parts gave way first, then the dense and fibrous parts were detached from the cortical mass; that, more tenacious and firm, spread out and resisted longer than the rest. Nothing remained of the fern-stems but the peripheric sheath or the disaggregated interior fibers; of the cordaites, sigillarias, and lepidodendrons only the cortical regions. The detached leaves formed other accumulations; and all these heaps, standing as obstructions in different places, were waiting for the arrival and passage of the water to yield to it innumerable fragments in very unequal degrees of decomposition. When the great rains came on, the waters, filtering in from every side, trickling down all the slopes, gathered here and there in temporary lakes, and finally overcame all the dams of organic matter they met—an immense mass of *détritus* going down to the lacustrine center. With these old and disorganized residues, the rains, which we must imagine to have been torrential, brought down also everything that would yield to their impulsion—tree-trunks, leaves, young shoots, and at times entire plants. It is these remains, so fresh in condition, these leaves so delicate, and clearly defined, these organs so whole which we see in our collections distinguishable in their slightest details, and lying spread out in the leaves of the great herbarium of which it is our privilege to turn the pages.

M. Grand' Eury's theory does not appear to offer anything that is discordant either with ancient phenomena or with those of more recent periods. It possibly has its place marked even now among the grand scenes of contemporary nature. We read in the narratives of the travelers who have ascended the great rivers of the interior of Africa, the Nile, for example, how their boats have been stopped for days at a time by submerged remains and the accumulations of plants hiding the river on which they were floating. In the face of such pictures, which show us sedges, water-lilies, and immense colonies of floating plants, under which the river has disappeared, while its eddies, its lagoons, and its deep basins are temporarily flooded after having been dry for months, we can not escape being carried back in mind to the phenomena, doubtlessly not quite parallel, but assuredly of the same order, to which was due the formation of the coals and lignites in ancient epochs. These were certainly not accidental or episodical phenomena, produced by circumstances which, once realized, were never to appear again, but occurred in the course of a series of analogous combinations of condi-

tions which may have been frequently repeated, and involve nothing incompatible with what is going on on the surface of the globe in our own day. In speaking thus, we do not regard Europe, but the interior of tropical countries, and the parts of those lands where water, heat, and an exuberant vegetation are combined upon a ground the configuration of which is agreeable to the material conditions that have been postulated in this sketch.

A SUPERSTITIOUS DOG.

By EUGENE N. S. RINGUEBERG.

THAT many of the higher animals are possessed of reason does not, in the light of modern science and recorded facts, need any argument; only the question of degree remains to be determined in the future.

It is among domesticated species that we have the best opportunities for studying the mental phenomena of the lower animals, but here they are often greatly modified by contact with man; and, as these abnormal modifications are the ones that we can most readily interpret, they must necessarily form the major portion of our data.

Observation of their habits can not fail to convince us that many individuals, if not all of the brute creation, are possessed of a considerable degree of imaginative faculty. Every one has watched a dog in dream-land: his feet will go through the motion of running; occasionally a few smothered barks will be heard, showing his eagerness in the imagined chase in which he is engaged; or his tail will wag rapidly, probably indicating a meeting with a pleasant acquaintance. He may even start up, and then, awakened by his energetic action, his countenance will show plainly, as he turns to lie down again, how sheepish he feels about the exhibition that he has involuntarily made of himself.

In the fall of 1879 an eccentric pointer came into my possession, or rather he adopted me for his master. He was a genuine canine tramp, with all the peculiarities of the human variety; stealing his food or lodging whenever he had a chance, or deferentially begging it when that method would answer his purpose better. He had been in the habit, as we afterward found out, of roaming about from place to place in the town, selecting first one home and then another. He was something over two years old when he came to me; his color was coal-black, and he soon learned to answer to the cognomen of Pluto.

After he had been with me a few months, certain peculiar mental traits began to manifest themselves. He became subject to attacks of apparent mental derangement, lasting from a few minutes to several hours, which increased in frequency and violence up to the time when

we disposed of him, two years later. These paroxysms would, at times, gain such complete control of his mind as to either paralyze or pervert all his physical senses.

The first one that I observed was brought on by the falling of a stick in the stove, back of which he was sleeping. Whereupon he started up, and commenced barking violently at a small leaf that was lying on the floor, every now and then making a dash toward it, after which he would retreat in the greatest terror. Then he would crawl slowly toward it again, and when he came within reach would strike at it with one of his fore-paws, drawing the paw back quickly with a little yelp, and then carefully looking it over as if to find an imagined injury, and licking it.

While the leaf was in the room he appeared to be entirely insensible to feeling or sound. Severe blows were administered with a stout stick, but they produced no more impression than if they had fallen upon the floor. He did not shrink, nor even by the slightest tremor give any indication that pain accompanied their infliction. Neither would he pay any attention to commands that were given in a loud voice close to his ear, although he had always shown himself obedient to any commands that he could understand; nor would any other sound, no matter how loud, cause him to make the slightest motion indicating that he had heard it.

After this his peculiar mental condition became more noticeable; the most trivial circumstance would sometimes be sufficient to destroy his mental equilibrium. A slight noise might bring on one of his paroxysms; but, singularly, it would generally have no effect unless it proceeded from the kitchen, which seemed to be to him a haunted chamber. Often in passing through the room he would cringe and put his tail between his legs.

At other times he would fix his eyes upon a spot on the ceiling or in a corner, or upon a towel hung up to dry, and would retreat from the object upon which his gaze was fixed, with dilated pupils and every other sign of intense fear of the imaginary "ghost." At these times his senses, instead of being simply deadened, were generally active, but in a perverted condition. If he was struck by a person behind him, instead of shrinking away, he would give a start toward the person who had struck him. Likewise a sudden noise, as the stamping of a foot, no matter from what part of the room it came, would invariably cause him to retreat violently from the imaginary object of his terror. He was apparently so prepossessed by one idea for the time being that, to his perverted senses, every noise was made and every blow was struck by the object which had excited him.

Sometimes he would stand on his hind legs and, directing his attention to the middle of the ceiling, would retreat backward, barking violently all the while. Then, seeming to be entirely mastered by his terror, he would drop on all-fours and run out of the house at full

speed, with his tail between his legs. It would be some time before he could be induced to enter the house again, and even then he would tremble violently.

Certainly in the case of this dog the mental phenomena exhibited can safely be termed superstition, and, whether it was normal or superinduced by momentary insanity, it was plain that for the time being he actually saw "ghosts." For this reason the case is a very interesting one, as it furnishes additional evidence of the similarity existing between the mental actions of man and those of the lower animals.

FROM BUTTERCUPS TO MONK'S-HOOD.

By Professor GRANT ALLEN.

TO look at these queer, irregular blue flowers, growing on a long and handsome spike in the old-fashioned garden border, nobody would ever dream of saying that they were in reality altered and modified buttercups. And yet that is just what they really are, with all the marks of their curious pedigree still clearly impressed upon their very form. Pull one of the blue blossoms off, and pick it carefully to pieces, and you will see how strangely and profoundly it has been distorted by insect selection. Monk's-hood is most essentially a bee-flower, and in examining it we see the results of bee action plainly set forth in every organ. If we pick a common meadow buttercup for comparison with it, we shall be able to see exactly wherein the two flowers differ, as well as why the one has gained an advantage in the struggle for existence over the other.

The outside whorl of the buttercup consists, of course, of five separate greenish sepals, which together make up its calyx. Inside the sepals come the five golden petals composing the cup-shaped corolla; and inside the petals, again, come the numerous stamens, and the equally numerous carpels or unripe fruits, each containing a single solitary little seed. Moreover, all these parts are regularly and symmetrically arranged round a common center, so as to form a series of concentric whorls. But when we look at the monk's-hood we see no such simple and orderly arrangement in its architectural plan. At first sight, we recognize no distinct sepals or petals: and the colored organs that take their place are very irregular in shape, and disposed in an unsymmetrical fashion—or rather, to speak more correctly, their symmetry is not radial, but bilateral. When we begin to pull our blue blossom to pieces, however, we gradually recognize the various parts of which it is composed. First of all come five sepals, not greenish as in the buttercup, but bright blue; and not all alike, but specially modified to fulfill their separate functions. The uppermost sepal of

all is helmet-shaped, and it forms the curious cowl which gained the plant its suggestive name from our mediæval ancestors. The two side sepals, to right and left, are flatter and straighter, but very broad, while the two lowest of all are comparatively small and narrow. The whole five are bright blue in color. Pull off these petal-like sepals, and you come to the real petals beneath them. At first you can hardly find them at all; you see only two long blue horns, covered till now by the helmet-shaped upper sepal or cowl, and each with a queer cup-like sac at its extremity, containing a small drop of clear fluid. That fluid is honey, but I should advise you to be careful in tasting it not to bite off any of the flower, for monk's-hood is the plant from which we get the now famous poison, aconitine; and a very little of it goes a long way. Unlike as they are to the familiar yellow petals of the buttercup, one can still gather from their position that the two long horns are really petals. But where are the three others? Well, you must look rather close to find them, and perhaps even then you won't succeed after all; for sometimes the three lower petals have disappeared altogether, being suppressed by the plant as of no further use to it. In this particular specimen, however, they still survive as mere relics or rudiments, three little narrow blue blades, not nearly as big as a gnat's wing, placed alternately to the lower sepals. As for the stamens, they are still present about as numerously as in the buttercup; whereas the carpels, or fruit-pieces, are reduced to three only, which in the ripe seed-vessels here on the lower and older part of the spike grow into long pods or follicles, each containing several seeds.

Thus, then, the flower of monk's-hood agrees fundamentally with the flower of the buttercup; while, at the same time, it has undergone some very singular and suggestive modifications. In both there are five sepals; but in the buttercup all five are alike, and all five are greenish; whereas in the monk's-hood they have acquired different shapes, exactly fitting them to the bee's body, and they have become blue, because blue is the favorite color of bees. Again, in both there are five petals; but in the buttercup all five are similar and yellow, and all five secrete a drop of honey at the base; whereas in the monk's-hood two of them have become long and narrow specialized nectaries, while the other three, being no longer needed, have grown obsolete or nearly so. Once more, the stamens remain the same; but the carpels have been immensely reduced in number, at the same time that the complement of seeds in each has been greatly increased by way of compensation.

Well, how are we to account for these peculiar modifications? Entirely by the action of the fertilizing bees. The secret of the monk's-hood depends, in the first place, upon the fact that its flowers are clustered into a spike, instead of growing in solitary isolation at the end of the stem, as in the common buttercups. Now, Mr. Herbert Spencer has pointed out that solitary terminal flowers are always radially sym-

metrical, and never one-sided, because the conditions are the same all round, and the visiting insects can light upon them equally from every side. But flowers which grow sideways from a spike are very apt to become bilaterally symmetrical; indeed, whenever they are not so, one can always give an easy explanation of their deviation from the rule. Probably the blossoms of the monk's-hood began by arranging themselves in a long and handsome spike, so as more readily to attract the eyes of insects; and that was the real starting-point of all their subsequent modifications. Or, to put the same thing more literally, those monk's-hoods which happened to grow spike-wise succeeded best in attracting the bees, and therefore were most often fertilized in the proper manner. Next, we may suppose, the large green sepals, being much exposed to view, began to acquire a bluish tinge, as all the upper parts of highly developed plants are apt to do; and the bluer they became, the more conspicuous they looked, and therefore the better they got on in competition with their neighbors, especially since bees are particularly fond of blue. As each bee would necessarily light on the middle or lower portion of the flower, he would begin by extracting the honey from the two upper petals; but it would be rather awkward for him to turn round head downward, and suck the nectaries of the three bottom ones. Hence, in course of time, especially after the flower began to acquire its present shape, the two top petals became specialized as nectaries, while the three lower ones gradually atrophied, since the colored sepals had practically usurped their attractive function. But as the flower can only succeed by being fertilized, all these changes must have been really subordinate to the great change which was simultaneously going on in the mechanism for insuring fertilization. Slowly the blossoms altered to the bilateral shape—they adapted themselves by the bee's unconscious selection to the insect's form. The uppermost sepal grew into the hood, so arranged that the bee must get under it in order to reach the long nectaries containing their copious store of honey. At the same time the bee must brush against the stamens, and cover his breast with a stock of adhesive pollen-grains. When he flies away to the next flower he carries the pollen with him; and, as he rifles the nectaries in the second blossom, he both deposits pollen from the last plant upon the sensitive surface of the carpels in this, and also collects a fresh lot of pollen to fertilize whatever other flower he may next favor with a call. The increased certainty of fertilization thus obtained enables the plant to dispense with some of the extra carpels which its buttercup ancestors once possessed; and, by lessening the number to three, it manages to get the whole set impregnated at a single visit. But, as three seeds would be a small number to depend upon in a world of overstocked markets and adverse chances, it makes up for the diminution of its carpels by largely increasing the stock of seeds in each.

Thus the whole shape and arrangement of the monk's-hood bear

distinct reference to the habits and tastes of the fertilizing bees. It is a mountain plant by origin, belonging to a tribe which took its rise among the great central chains of Europe and Asia, and these Alpine races are usually highly developed in adaptation to insect fertilization, because they depend more absolutely upon a few upland species than do the eclectic flowers of the plains, which may be impregnated haphazard by a dozen different flies, or moths, or beetles. We can still dimly trace many of the links which connect it with very simple and primitive buttercups, if not directly, at least by the analogy of other plants. For all the buttercup tribe show us regular gradations in the same direction. The simplest kinds are round, yellow, and many-carpeled, like the buttercups. Then those species which display their sepals largely have dwarfed petals, like hellebore and globe-flower, or have lost them altogether, like marsh-marigold, which trusts entirely for color display to its big golden calyx. The still higher anemones have the sepals white, red, or blue; and the very advanced columbine has all the petals spurred, and developed into nectaries, like those of monk's-hood. But columbine still keeps to single terminal flowers, so that here the five petals remain regular and circularly symmetrical, though the carpels are reduced to five. Fancy a number of such columbine-flowers crowded together on a spike, however, and you can readily picture to yourself by rough analogy the origin of monk's-hood. The sepals would now become the most conspicuous part; the two upper petals would alone be useful in insuring fertilization, and the lower ones would soon shrivel away from pure disuse. The development of the hood and the lengthening of the upper petals would easily follow by insect selection. It is a significant fact that our only other spiked buttercup, the larkspur, has equally irregular and bilateral flowers, though its honey is concealed in a long spur formed by the petals, and accessible to but one English insect, the humble-bee.—*Knowledge.*

ON THE COLORS OF WATER.

By M. W. SPRING,
OF THE UNIVERSITY OF LIÉGE.

VIEWED in relatively shallow masses, clear water appears wholly colorless. In our daily dealings with the liquid we seldom have occasion to observe it in great depths; hence it has been generally believed that water is quite destitute of color. The ancients were accustomed to explain the transparency of some bodies by assuming that they partook of the nature of water; and we now speak of a diamond as of the first water, to emphasize its perfect transparency and colorlessness. If, however, we regard the larger masses of water in

nature—the seas, lakes, and rivers—we shall receive a different impression. In these, the water not only appears colored, but of various colors, and of a rich diversity of shades. The Mediterranean is of a beautiful indigo, the ocean is sky-blue, the Lake of Geneva is celebrated for its lovely and transparent azure waters; the Lake of Constance and the Rhine, the Lake of Zurich and the Lake of Lucerne, have waters quite as transparent, but rather green than blue; and the green waters of the little Lake of Kloenthal, near Glaris, can hardly be distinguished from the surrounding meadows. Other waters are of a darker color, like those of the Lake of Staffel, at the foot of the Bavarian Alps, which was quite black the day I saw it, though clear in shallow places.

These facts start the questions whether water, after all, has not a color; if it has, what the color is, and what causes the varied tints under which it is seen. The solution of these questions has long occupied the minds of scientific inquirers, and it can not yet be said that they have been answered. Disagreement still prevails respecting them.

M. Durocher, in his "Studies of the Glaciers of Northern and Central Europe," has expressed the opinion that the blue color of some waters is of glacial origin, and that it is so peculiar to water from snow-fields and glaciers as to constitute a mark by which to distinguish whence it has proceeded. "If the color of water is really blue," he adds, "the substitution for it of gray or greenish tints proceeds in the majority of cases from organic substances, chiefly vegetable rather than animal."

M. Durocher's view is disputed by M. Th. Martins, who points to the snow-fed Lakes of Sioron and the Bachalpsee, as one azure blue, the other yellowish green, and the Lake of Brienz, whose yellowish-green waters, after crossing the Isthmus of Interlachen, become blue in the Lake of Thun.

Bunsen was the first one to deny, with any real knowledge, the absence of color in water. Struck with the green-blue color of the hot water of the Icelandic geysers, he examined pure water in a tube, found it blue, and concluded that that was the true color of the liquid, while other colors observed were derived from foreign matters or by reflection from a colored bottom.

Tyndall, Soret, and Hagenbach took up the question about twenty years after Bunsen. Tyndall found by experiments on polarization that the blue of the atmosphere was caused by reflection of the shorter blue light-waves at the expense of the longer waves, from particles of aqueous vapor in an extreme state of division, which he called nascent cloud. If the particles were larger, longer waves would be reflected, and the color would approach white. Soret, seeking to learn if the blue color of the Lake of Geneva had not an analogous origin, applied the polarization experiments to it, and concluded that it contained

minute particles similar to those found by Tyndall in the atmosphere. Hagenbach repeated the experiments, with like results, in the Lake of Lucerne; and Tyndall, a year later, with water of the Mediterranean and the Lake of Geneva, sent to him in London. Mr. Hayes examined the water of the Lake of Geneva, to see if it did not contain a coloring substance, and found none.

The later of these experiments indicate that, contrary to Bunsen's belief, water by itself may be colorless, but nothing is less certain. M. Soret says that the lake was still blue in cloudy weather, when he could not get a trace of polarization effects. Is this not enough to prove that reflection is not the only cause of color in water? Moreover, if the blue in water were wholly of the same origin as that of the sky, the light transmitted by water should be crimson, as that which is shown on the tops of high mountains, or which is transmitted through the clouds at the rising and setting of the sun; but nothing of the kind is the case. Professor Tyndall states this, and Father Secchi has established the absence of the red and yellow from the absorption spectrum of water. It is also well known to those who have had occasion to make submarine excursions, or who have visited the glacial grottoes in Switzerland, that the transmitted light has a blue tone, and the red is so weak that the figures have a livid aspect.

These facts show that the question is still waiting a definite solution. We now turn to the explanations which have been offered of the diversities in the colors of natural waters.

According to Arago, water has two colors, "a color of transmission and a color of reflection, wholly different from the other. It appears blue by reflection, and its transmitted color is green." This supposition can not be reconciled with optical laws, but Arago used it to explain the variations of tint in the water of a shallow, white-bottomed sea. "When the sea is deep, light is reflected from the water and appears blue; but, if it is not very deep, the sand at the bottom receives the light through a stratum of water. The light then reaches the bottom, already green, and, in returning from the sand to the air, the green color is deepened, frequently so much as to predominate, on coming out, over the blue. This, probably, is the whole secret of those shades which are in calm weather the sure and valuable index to the experienced sailor of the depth of the bottom. This explanation fails when it is applied to other quarters than those for which Arago conceived it. The Swiss lakes are green, or blue, independently of their depth. Arago suggests, after Davy, that the change from blue to green may be caused by the presence of vegetable, M. Durocher of colored, matters. These suppositions are gratuitous, and supported by no evidence. H. Sainte-Claire Deville, in 1848, analyzed a number of natural waters, and found that the blue ones gave hardly perceptible colored residues, while the green ones yielded such considerable quantities of organic matter that the soluble salts became yellow after

evaporation. According to this, green waters, and, *a fortiori*, yellow or brown waters, owe their color to the presence of a small quantity of yellow mud. If pure water is really blue, the presence of a small quantity of yellow matter would be enough to turn its color to green or yellow. The same idea was advanced some time ago by M. Wiltstein, who believed he had proved, by analyses of the waters of a number of Bavarian streams and lakes, that brown and yellow waters contained more organic matter than green ones, and that they were less hard than the latter. He thought that mineral substances of themselves had no effect on the color of the water, but that organic substances, naturally brown, existing in it as humic acids, were held in solution through the presence of alkaline matters with them, and that they made the water, according to their abundance, green, yellow, brown, or black. His views are not supported by the results of my analyses, which indicated that the colors of different waters on which they were made bore no relation to the quantity either of organic matter or of alkalies held in them. I have also not been able to find any relation between the color of water and its hardness or softness. It is, however, probable that very dark water may owe its color to dark organic matter dissolved in it.

M. Schleinitz attributes the diversities in the color of sea-water to variations in the quantity of salt dissolved in it. During a voyage in the Gazelle, from Ascension to the Congo, he observed that the blue water had a higher specific gravity than that which was of a greenish tinge. This observation leads to an erroneous conclusion, but affords a confirmation of some results which I have reached.

M. J. Brun has noticed in the water and the ice of the Lake of Neufchâtel an alga which is green, orange, red, or brown, according to the stage of growth it has reached, and black after it is dead. Its presence would not be without influence on the color of the lake.

This review shows that the problem of the color of water still calls for more investigation. It may be useful to speak of a few researches that I have made. My object was to determine the color of pure water, and to observe the variations in color produced by the presence of different substances. I used glass tubes, five metres long and four centimetres in interior diameter, closed at the end with glass plates, and passing through a black sheathing that intercepted the side-light. They abutted against a ground-glass pane in the window of my laboratory, so as to receive diffused light in the direction of their axes.

M. V. Meyer, who used a similar arrangement, found the color of distilled water to be a blue-green. I found it pure blue. In my first experiment, I also found distilled water of a blue-green color, like that of a diluted solution of ferric sulphate. A second experiment, with freshly distilled water, gave a pure sky-blue, which in the course of seventy hours became blue-green like the former water, without losing any of its transparency. This indicated that the distilled water of

laboratories is not perfectly pure, but that it contains substances that will change in time. These substances might be mineral or organic, or even living organisms. Wishing to ascertain whether the last was the case, I added to the water in one of the tubes $\frac{1}{10000}$ of bichloride of mercury, while I left that in the other tube unchanged. The small quantity of bichloride did not at all affect the color of the water to which it was added. In the course of six days the water which had been left alone became blue-green, while that to which bichloride of mercury had been added preserved a fixed blue, and exhibited no sign of change for three weeks; but, when the salt was put into the water that had turned blue-green, that began slowly to turn blue again, and this process continued for nine days, when it stopped, without the blue color having been quite restored. Inasmuch as the bichloride of mercury is extremely deadly to minute organisms, we have a right to conclude that life exists in the distilled water of laboratories, and that such water contains also the aliments required for its development. How can organic germs exist in water that has just passed through the process of distillation? Tyndall has shown the possibility of vapor taking up germs as it passes through the air. M. Stas has proved that distilled water may contain volatile organic matters which after a little while become spontaneously fixed. We may, then, conclude that our distilled water continued blue as long as the organic matters contained in it continued volatile, but that it turned green as they became fixed.

It was necessary to obtain distilled water certainly free from organic matter. I did this by an adaptation of M. Stas's process of distilling spring-water over a mixture of manganate and permanganate of potash into a cooling-vessel of platinum. The resultant water, which met every test of its purity, when placed in the tubes, displayed a color to which only the clearest blue of the sky, as seen from a mountain-top on a perfect day, can be compared, the hue of which was not changed after it had been left in the tubes for two weeks. The color was evidently not due to reflection from minute particles, for it was a color of transmission and had not a tinge of red in it; moreover, if it was due to the presence of foreign particles, all liquids under the same conditions ought to have a bluish tinge. But amylic alcohol, distilled under circumstances favorable to the absorption of fine particles, was colorless, while acetic acid and ethylic alcohol were yellow, when seen through a thickness of five metres; and, though the color was effaced as the thickness of the masses was reduced, no trace of green or blue appeared in the liquids. It seemed proved to me that water, as pure as we can get it, has a blue color, which proceeds, not from reflection, but from an absorption of the yellow.

To perfectly clear lime-water I added enough of a solution of carbonic anhydride to cause the formation of a barely visible precipitate, and then poured the liquid into one of my tubes of observation. The

liquid was entirely opaque, as much so as if it had been ink I had put into the tube. I then took the mixture from the tube, diluted it to a suitable degree with pure water, and introduced a current of carbonic anhydride sufficient to precipitate the lime as a carbonate, and finally to dissolve the carbonate as an acid carbonate of lime. The current of carbonic anhydride was interrupted from time to time, and the liquid was clarified and examined in the tube, and, as I did so, I could see the opacity slowly disappear, letting in first a brown light, then clear brown, then yellow, then green, and at last, after eighteen hours of circulation of the carbonic anhydride, the liquid had again become blue, but with a tendency to green. Thus, by the combined action of carbonic anhydride and carbonate of lime, it is possible to produce all the colors of natural waters, from opacity to greenish-blue. I reversed the process, and from a green saturated solution of bicarbonate of lime and carbonic acid, by gradually expelling the carbonic acid, obtained a succession of colors, in inverse order, to complete opacity. Similar processes with solutions of other salts gave results agreeing with these.

My experiments enabled me to verify several facts. First, we find that not all of a luminous ray can pass through a considerable mass of a liquid holding foreign bodies in suspension, even when the latter are transparent or colorless. Further, it is not necessary that the body in suspension be in the solid state. The important point is, that it be competent to reflect light. Then the light-rays of feebler intensity suffer extinction, one after another, according to the thickness of the medium, till the yellow rays, the brightest to our eyes, are the last to survive the struggle. It is not essential to the production of this phenomenon that the medium be liquid. It may be observed in our atmosphere, where the shadow of a cloud of smoke will appear yellow or brown according to the thickness of the smoke. It may be that the reflecting particles can be dispensed with, and we may say generally that, when light passes through an optically resistant medium, the yellow rays are the last to be extinguished.

Other experiments have satisfied me that the yellow tint exists not only when the liquids contain matter in suspension, but also when they contain it in solution to the point of saturation, or when precipitation is about to begin, at which point there still remains enough of this color to form with the natural blue of the water a green. This condition may be called, in analogy with the nascent cloud of Tyndall, that of nascent precipitation. We now come to another view, which is supported by a small number of experiments I have made with reference to it, that the obstruction of light, inducing the yellowish tint, which is produced by any salt, depends less on the quantity of the salt present than on its being near the stage of precipitation. Small quantities of a feebly soluble salt produce the same effect as large quantities of a more soluble salt. The variety in the colors of natural waters

may, then, be thus explained: Absolutely pure water, viewed in masses of sufficient thickness, is of a beautiful blue color. If it holds in complete solution colorless salts in small mass, its color is not changed; but, in proportion as it may contain matter on the verge of precipitation, the light traversing it will be of a yellow or darker color, until a stage is reached when the liquid will let no light through, and becomes opaque or black. The yellow light will combine with the blue light of the water, and thus will be produced green-blue, bluish-green, and green tints, according to the strength of the yellow. If the latter is very strong, the dark blue will be wholly smothered, and the water will appear yellow, brown, or of a still darker color.

In nature, generally, the feebly soluble substances contained in natural waters, and appearing, perhaps, in the state of nascent precipitation, are carbonate of lime or magnesia, silica, silicate of aluminum, and alumina. A blue water should contain carbonate of lime more completely dissolved in proportion as it is more distinctly blue, and should consequently have in it enough carbonic anhydride to produce the acid carbonate of lime. A green water, on the other hand, should contain carbonate of lime in less complete solution, as would be the case if there were a less relative proportion of carbonic anhydride in it. The blue waters of the Rhône and the green waters of the Rhine, as analyzed by Sainte-Claire Deville, illustrate and confirm this rule. It may also be presumed that a blue water, containing limestone in full solution, should become green when lime is added to it. This is illustrated on the north shore of the Lake of Achen, where the blue waters of the deep lake become chrome-green when they break over the limestone pebbles of the strand, and, generally, in the greener color of the bottom and shore waters of seas and lakes. Other substances than lime, particularly silica and alumina, may produce the same effects, but their action is more complicated. These substances, without being really soluble in water, are pseudo-soluble, or form an emulsion with it; and water which has taken them up from the ground over which it flows does not become perfectly clear on standing. If, however, it meets a solution of chloride of sodium, alumina, or silicate of alumina, it is precipitated rapidly; and this is what takes place at the mouths of rivers, and is the immediate cause of the deposits out of which deltas are built up. The changes in the color of the sea-water observed by M. Schleinitz, on board the Gazelle, may be accounted for by reference to this fact.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

A WONDER FROM THE DEEP-SEA.*

By M. L. VAILLANT.

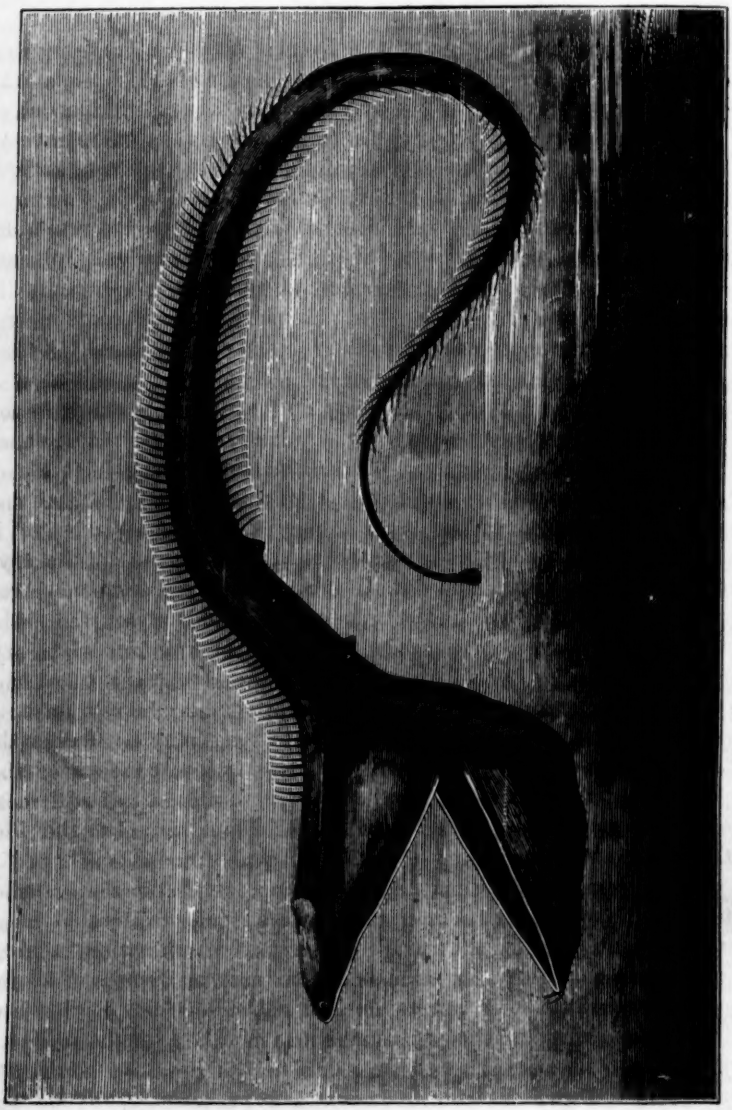
DURING the last voyage of the French deep-sea dredging-ship Travailleur, a fish was found, off the coast of Morocco, at the depth of about 7,500 feet, which may certainly be regarded as one of the most singular beings yet brought to light in any of these investigations. It is about eighteen inches long, and three quarters of an inch thick at the thickest place, and is deep black. Its body, the form of which is marked in front by an enormous mouth, somewhat resembles that of a macrouran, and tapers regularly from near the anterior quarter, where the external branchial orifice may be seen, till it terminates in a point at the caudal extremity.

A most singular appearance is given to the fish by the disposition of the jaws and the conformation of the mouth. While the head is very short, being less than an inch and a fifth in length, the jaws and the suspensorium are excessively long, the latter measuring more than three inches and three quarters. Hence the angle of the joint is put very far back, at a distance from the end of the snout about three and a half times the length of the cephalic portion. The suspensorium is probably composed of two pieces, one basilar, analogous to the temporal, the other external, and doubtless representing a tympano-jugal. The upper jaw is constituted of a long and slender stylet, the situation of which nearly corresponds with that of the intermaxillary, while the maxillary is wanting, unless we assume that the two bones are confounded. Slight, tooth-like granulations may be felt on both jaws, and two teeth, about two millimetres long, may be seen at the end of the mandible. The buccal orifice is, in consequence of this disposition, enormous, and is the introduction to a cavity of still more astonishing dimensions. The upper jaw is, in fact, united to the sides of the head and the fore part of the body by an extensible fold of the skin, which permits a considerable separation. Between the branches of the mandibles is extended an analogous but more dilatable membrane, containing, as is shown by histological examination, a great number of elastic fibers, in bundles, which may be compared to the pouch of the pelican. In consequence of the divergence of the jaws and the extensibility of the membranes, the mouth, with the pharynx, forms in the fresh animal a vast tunnel, of which the body of the fish seems to be a drawn-out continuation. It is presumed that food was accumulated, and partly digested, in this pouch.

The organs of locomotion are most rudimentary. The swimming-fins are reduced to two little appendages, situated near where the pec-

* From a paper read before the French Academy of Sciences.

toral fins should be; the ventral fins are wanting. A dorsal fin, which is prolonged to nearly the whole length of the back, without quite reaching the tail, begins at about the length of the head back of the occiput; the anal fin begins a short distance back of the anus, and



THE DEEP-SEA FISH EURYPHARYNX PELECANOIDES.

ends at the same point as the other. The extremity of the body is wrapped in a little membranous fold, a kind of caudal fin. The slender and flexible rays of these singular fins are not articulated, nor, so far as can be judged from the preserved specimen of the animal in liquor,

are they connected by a membrane. Without engaging in a technical description of the organs of respiration, which are so far unique among bony fishes, or of the organs contained within the abdominal cavity, it is important to take notice of the complete absence of the swimming-bladder. This fish offers in certain features resemblances to the *Anacanthini*, to the *Scopelidæ*, the *Stomiadæ*, and to certain apodes, but has also characteristics which separate it distinctly from them. It must be regarded as the type of a new family, of which, unless it may be found to be related to the malacosteus, it is the only representative. I propose for it the name *Eurypharynx pelecanoides*.

GYMNASTICS.*

By ALFRED WORCESTER, A. M.

THE very name carries our thoughts back to the ancient Greeks, who provided for their children the most complete physical training that the world has ever known. Men and women alike took pains and pride in the development of perfect bodies, and their success, recorded in inimitable statues, affords models of human beauty and strength. In examining their system we discover much that is foreign to our civilization. We can not find the time for daily anointing with oil, powdering with dust, and long exercising in the sunshine—hardly time, indeed, for even an abridgment of their luxurious bathing; and yet, till after we do devote time and care to the development of our physical natures, need we hope for anything like the splendid equipoise of the faculties that characterizes the Greek excellence of manhood. Passing now to Rome, we find early in her history the vigor always characteristic of a new race. It matters not how impoverished their ancestry, colonists cut off from the sloth of old centers of population, forced to battle with the earth itself for their support, soon retake the vigorous manhood their fathers gradually lost. And the Romans, in their turn, driven under the yoke by a sturdier race, proved no exception to the general rule that, as ease of living rises above a certain line, people deteriorate physically. That there is no underlying law of nature necessitating this result is proved by the Grecian training which raised the body to a far higher than any barbarian standard. In the age of chivalry we can find something of a similar physical excellence, and again its plain dependence upon a high estimate of the value of a perfect body and upon great pains taken for its procurement. As this age gave way before gunpowder and the Church, as men discovered the uselessness of heavy armor, battle-axe, cross-bow, and lance,

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and as they were taught the doctrine of the necessity of body-mortification in order to perfection of soul, there prevailed a total disregard of the physical conditions necessary to our well-being. Even bathing was held to be a vanity of worldly savor, and gymnastics would doubtless have been considered worse than folly. This state of darkness lasted in Europe till the beginning of the present century, when Ling, of Sweden, after most persistent effort, succeeded in introducing his "movement-cure." For every one of the five hundred muscles, and for every imaginable disease, this system provided some kind of exercise. Its distinctive feature was its adaptability to diseased conditions, and there can be no doubt of its usefulness. As a means of cure it is still somewhat in use, and would probably be still more used were it not in the hands of those who make for it altogether unreasonable claims. And still, for those in search of the proper movements for exercising any given set of muscles, Ling's system, as set forth by Dr. Roth and many other of the great gymnast's disciples, furnishes abundant and explicit instruction. Also in the early years of this century, a system of physical training was introduced in Prussia by Jahn, not for the cure of disease, but for the development of strong, serviceable bodies. Strangely as it now sounds, Jahn's system was opposed by the Government, on the ground that it made the people less manageable, and more intolerant of church and state. Could better evidence be offered both of the good effect of gymnastics and also of the fearful ignorance that then prevailed of the value to the Church and to the state of a vigorous, healthy people? In spite of royal opposition, however, gymnastics grew in German popularity. The annual meetings of the Turnvereine, like the old Olympic festivals, fostered an enthusiasm for body-training, which, in turn, so far proved its worth to the state that in 1853 it became a recognized branch of public instruction. Since then, it will be remembered, Prussia's advance has been uninterrupted. To her armies Denmark, Austria, and France have in turn succumbed. Is it not possible that her glory is due to the thorough physical training of her children?

Coming now to our own country, we find by the year 1825 gymnastics taught in a private school at Northampton, Massachusetts, by a Professor Beck, who a few years later published a translation of Jahn's system. The school seems to have attracted considerable attention, but we can easily imagine how silly such artificial exercise must have seemed to those whose backs ached from their daily work. Little prepared were our New England parents to understand that, by this kind of exercise, backs and limbs could be developed that would easily carry burdens which untrained muscles would groan under. This same popular ignorance exists to-day. The majority still believe that hard manual labor affords better exercise than can any system of artificial gymnastics; whereas, instead of the equally developed elastic body resulting from gymnasium-training, we have in the laborers

a stiff-jointed, clumsy, ill-proportioned body. In the fifty years since the introduction into this country of systematic body-training, there, nevertheless, has been great gain in the popular estimation of its advantages, as is shown by the almost countless systems that have received ephemeral patronage. Witness the innumerable pieces of gymnasium apparatus that have been advertised, and widely believed, to prevent or to cure all manner of woes and ills. At one time it is the spirometer, which, if blown into daily, will prevent consumption; then it is a patent kind of lifting-machine by which a man may soon learn to lift a ton; or rubber bands which deluded purchasers would surely find it easier to stretch as the rubber grew older. This long list of nostrums it is important for us to notice as in great measure accounting for the distrust many intelligent people have of the whole subject of gymnastics. In their ignorance they have believed the quacks, and, having suffered at least in purse, they now are shy of the subject in general. The fact is plain that their distrust is because more good has been claimed, and has been temporarily believed, to result from the use of one especial kind of exercise than could reasonably be expected from all kinds together. Honest efforts have meantime been made to introduce systematic exercise. Dio Lewis twenty years ago carried on in Boston a normal school of gymnastics. Several hundred teachers were graduated, and for a time were in considerable demand. Later, Dr. Lewis had a great girls' school in Lexington, where, in Bloomer dress and broad-soled boots, girls were certainly taught to walk long distances. The new system, as he called it, contained this principal innovation: Exercise was to be by couples holding rings or wands, and with music the doctor enthusiastically believed that he had borrowed all the charm of the dance, but it was found that, unlike dancing, in his evolutions all the fun was in learning how, and now his system is quite forgotten. In bringing our history of gymnastics down to date, it is necessary to mention the gymnasia of city clubs and colleges. Till within a few years a typical gymnasium of this sort was a medley collection of apparatus under the care of a janitor, who possibly knew something of the art of boxing. It was the fashion for the would-be gymnast to work at this or that according to fancy, always taking care, however, to exercise only his best-developed muscles. If a good vaulter, he spent his hour in vaulting; if strong-armed, his exhibitions were on the swings and bar. These gymnasia would have been even less patronized except for the training in them of the sporting-men, who by general opinion were obliged to work diligently at some kind of machine if the next summer they were to beat other clubs and colleges on the field and river. Of their training and violent exercise little need be said, because they were so few, except that the wide-spread fear of harmful results from excessive exertion in these sports seems in the light of recent careful investigation to have been greatly exaggerated. The poverty in the results of

these gymnasia was generally so disappointing that they were fast becoming unpopular, when happily the present successful system came in to supersede them. In order thoroughly to understand this new system one must experience its sure beneficent effects, which depend not upon newly-devised apparatus, although great improvements have been made in this respect, but upon the application of scientific principles in the employment of old methods, thereby combining all the possible advantages of every other system. Its main features are: First, a thorough physical examination of the person in comparison with the normal type, proper allowances being made for race, age, sex, and temperament. Second, carefully prescribed exercise to correct deformities and deficiencies, and to induce symmetrical development. Third, special directions as to proper times for exercise, and for care of the body after exercise. It will readily be understood that such a system requires professional oversight and direction. Before discussing the opportunities for profitable introduction of this system, let us consider its theoretical advantages and its practical results.

If, as may naturally be supposed, the human body is designed to meet the physical activity of life in simplest conditions, where all the muscles find necessary employment in procuring food and protection, then, in conditions of life where such necessity does not exist, it follows either that the body has unlimited power of adaptability, or that sooner or later in the deviation from primitive conditions the body will not naturally attain its maximum of possible vigor. The latter is, of course, our only conclusion; and it needs but to be pointed out that, in our present complicated civilization, where the demands upon nervous and mental force are so disproportionally great, this deviation is excessive and increasing, in order to emphasize the need of supplying artificially the lost conditions of maximum body strength. Our subject naturally divides, according to purposes, into exercise designed for the preservation, and into exercise designed for the development, of health and strength. Of the two subjects the latter is the more important. Once given a well-developed body in fine condition, and obedience to certain definite rules will keep it so; while, on the other hand, to bring about this condition is often impossible, and always demands skill and painstaking. No time may safely be wasted: the earlier the start and the more constant the care, the better are the possible results. A month's work in correcting a child's deficiencies or deformities may be worth years of such labor later on, when the skeleton is thoroughly ossified. And yet, although the plastic stage of youth is so much the more favorable time for such work, there is still such a willing response on Nature's part, that almost at any age our efforts in this direction are liberally rewarded.

In considering the results that may be expected from exercise directed to certain ends, let us take first the body framework. The shape of the bones most concerns us. When we remember the pliant

condition of young bone and the manner of its growth at the epiphyses, how easy it is to imagine the advantage of regularly stretching the cartilage in the lines of the most serviceable shape and position of the future bone! We know how easily the thorax-walls, for instance, become misshapen from abnormal pressure within or without, even from lazy slouching; and we know too how quick and lasting is the "setting-up" of the West-Pointers. Their splendid carriage is due simply to the stretching of ligaments and cartilage, maintained till the natural equilibrium of muscular force is regained in the new position. Merely for æsthetic reasons this result is well worth the cost. Of far greater importance are the increase of chest-room and the greater resistance to fatigue thus gained.

In passing now to the theoretical advantages of regularly exercising the voluntary muscles, little consideration need be paid to the supposed advantage of increase in size. Muscles readily respond to increased demands by rapid growth in size, and, for those whose duties do not require large muscles, it is questionable if they are any better off with them. A blacksmith's arm may be considered rather as a superfluity if on a parson. For some sets of muscles the blacksmith and the parson, and in fact all people, have equal need, and, in order to be equally vigorous in their respective stations, the development that the blacksmith gains naturally must, by others leading a sedentary life, be obtained artificially. Of prime importance to all are both the voluntary and the involuntary muscles of respiration. So directly does our physical health depend upon their continued vigor, that nothing short of their highest possible development should satisfy us. Especially is this true of the abdominal muscles, which should give not only most valuable assistance in the mechanism of breathing, but also a support of exceeding value to the viscera. No other set of muscles has suffered more in the change from active to sedentary life. Corsets are proof of this. Fashion is by no means wholly responsible for their almost universal use. They do not come and go, but, in spite of all efforts at dress reform, corsets hold their sway, because their wearers feel better in them. This will continue to be the case until the muscles whose office they partially supply are developed by exercise designed to take the place of what is no longer naturally obtained.

It is not sufficient to have merely large muscles. Like raw troops, their usefulness depends upon constant discipline. This widely-recognized fact is often wrongly explained, as, for instance, by the theory that our nerves need exercising. In this age, nerves need no such stimulus. A much more probable theory is given by Maclaren, of Oxford, namely, that the potential energy of body-substance depends upon its *newness*, which may be explained by the facts that the potential energy of combustible material is directly proportional, and its chemical stability is inversely proportional, to its molecular com-

plexity. There can be no doubt that this complexity, if not immediately, is then gradually, lessened in the animal economy. There are probably countless stages in the oxidation into urea of each particle of nitrogenous tissue, be it cell-wall or cell-protoplasm, and at each stage of the process the particle will have consequently less potential energy and greater chemical stability; that is, less usefulness for the exhibition of vital phenomena. It is therefore impossible to lay up a permanent stock of physical vigor. Even if we should keep motionless as statues, our stock would steadily disappear. Not in size, but in quality, would come the great depreciation. Nature's own tendency to replace lost organic material with new teaches us how this depreciation may be avoided. In the body there is at best only a sluggish tendency to replace poor with better material, but by destroying that poor stuff we can arouse the organism into active efforts for its replacement. This is the philosophy of the advantage to muscles of regular exercise.

The full development and the continued vigorous condition of the circulatory system are of far more importance to the general health than are similar states of the voluntary muscles and the skeleton, whose importance is mainly in relation to the respiratory and circulatory systems. If we desire to possess maximum vigor, we must have large lung capacity, and, most of all, a stout heart and elastic arteries. In two great ways are the latter needs procured by physical exercise: First, in response to unusual demands there is an accelerated destruction of degenerating substance in the involuntary muscles of the heart and arterial walls, which, as we have seen, is requisite to the substitution of newer and more useful substance in them. Second, by the increased blood-tension, the coronary arteries and the vasa vasorum, in the intervals of dilatation, will carry more nourishment to the heart and arterial walls. It is hardly conceivable that a person, accustomed to regular physical exercise, should ever suffer from a fatty degenerated heart. And, with regard to this increased blood-tension gained in exercise, it is probable that it is productive of many other valuable results. For instance, the blood is drained from the overcharged brain, not merely as might be effected by venesection, thereby requiring an increased production, but by diverting its course into previously only half-dilated channels, whose sluggish currents now become swift streams of lively blood. And, again, in consequence of this heightened blood-tension, both the secretions and the excretions are increased, thereby developing the capacity of the glandular organs, and also directly aiding the body, both in the riddance of waste material and in the production of the necessary fluids. Of especial advantage, then, would be this increased blood-tension in aiding digestion. The circulation of the blood is, of course, directly aided during physical exercise by the rhythmical pressure of the muscles upon the veins, whose valves allow the blood to be driven only in the right direction.

In considering the effect of exercise upon the respiratory system, it is well understood that, in order faster to rid the body of waste gases and to obtain the needed oxygen, the respirations are increased in amount and frequency. Merely from this increased work the lung-tissue would be expected to increase; and there is still further influence to this end, from the pressure of air within the lungs, induced by forcibly holding the breath for a moment, as is naturally done at the inception of muscular exertion. This pressure must tend to dilate the alveoli to their full extent, and it also serves to aid the passage of oxygen through the membranes, and its solution by the blood.

Such, then, are some of the theoretical advantages of physical exercise. Let us now examine the results. Unfortunately, exact records of gymnasiums are as yet rare. Although indefinite reports are of comparatively little value, still it is possible to appeal to the personal experience of many to substantiate the claims made for systematic artificial exercise. And, indeed, it is only by this personal testimony that we can get at the indirect, yet perhaps the most valuable, results. No tabulations can represent the after-glow, and the consciousness of increased strength, purified blood, and cleared brain, which delightfully reward such exercise. Equally difficult would it be to describe the body alacrity so acquired, which, without stopping to discuss its origin, is a very valuable result, and never otherwise attainable. We are, however, not entirely dependent upon our own limited experience, nor upon indefinite statements of results. Though strangely few, we still have some unquestionable records of not slight deformities and deficiencies corrected. In searching for measurements that will even approximately represent the vigor of the body, we can not depend upon measurements of muscles, which can never be accurate, and, even if they were so, are no sure guide. The weight and height are also alone useless; but all these measurements taken into account, together with the muscular strength and the general character of the flesh, give a tolerably fair idea of the person's condition. If to these measurements be added the girth and expansive power of the chest, and the lung capacity, a far more accurate idea will be obtained; and the gain in these measurements, after regular terms of exercise, may fairly be assumed to represent its advantages. Taking now the most important measurements, we find reported from various gymnasiums an increase of two inches in passive girth of chest, of four inches in expansive power, and of fifty cubic inches in lung capacity. These gains have been obtained in six months' time, not only in college students, army officers, and school-boys, but also in city girls. Who can properly estimate the advantages of such increased breathing power? In enabling the fortunate gainer more easily to meet the wear and tear of daily duties, or the possible onslaught of acute disease, what invaluable assistance would be rendered by these fifty cubic inches of lung capacity!

As a preventive of disease, there can be no question of the advantageous results of exercise, and in this connection may be quoted the reports from Amherst College, which show a remarkable decrease in sickness since the introduction of compulsory gymnastics, and a decrease in the proportion of three sick in the freshman year to one sick in the senior year, as a result of four years' training. Another most excellent result mentioned in the same reports, which can not be too greatly emphasized, is the increase of the person's own regard for his body. After realizing the cost of physical strength, one is far less likely to waste it wantonly.

What has been said of the advantages of physical exercise in developing the body applies even more forcibly in regaining a vigorous condition after debilitating disease. For, while in growth we have natural tendencies toward excellent development, on the other hand in the convalescence of adults the only stimulus is that of needed strength; only by exertion can this stimulus be gained. To bring a convalescent fully up to par, more is needed than tonics and a nutritious diet. And if doctors oftener prescribed and required definite daily amounts of exercise, their patients' recoveries would be hastened, and the striking change for the better, now so often immediately following the doctors' dismissal, would then be less noticeable.

Especially applicable would such practice be in hospitals where patients are under stricter surveillance, but surrounded with less inducements to exercise themselves; comfortably cared for, with no necessity for exertion, it is often no easy job to rouse them to active recovery of strength. The added expense of a suitable gymnasium under competent supervision would, doubtless, be saved by the patient's shorter stay in the convalescent condition.

In the case of physical exercise, no exception will be found to the general rule that the efficacy depends upon the accuracy of the prescription.

Good results are not to be expected from careless following of careless advice. Those whose need is greatest are often the most loath to undertake any exercise, and hence such will be sure not to avail themselves of any indefinite instructions in this respect; while, on the other hand, some, out of over-conscientiousness or enthusiasm and in lack of explicit directions, are liable by overdoing to receive injury instead of benefit. It should be borne in mind that it is the physician's duty to teach his patients that they may so far as possible live intelligently as regards their own peculiar conditions. If in his trained observation there is on his patient's part a need for greater lung development, then every means should be taken to gain the patient's intelligent co-operation in securing this result.

If a well-appointed gymnasium is at hand, the physician should be as well able to prescribe the exact use of its different apparatus as he is to write for doses from the adjoining drug-store. Nor is it safer to depend upon the skill of the average gymnasium director, than it is

upon the druggist, for particular instructions. It is as likely that one as the other would be able to recognize, for instance, the difference between functional and organic heart-murmurs, which would call for such fundamentally different treatment. If no gymnasium is at hand, the doctor should still be as well able to advise about the use of extemporized apparatus and the various forms of exercise without apparatus as about the use of other domestic remedies. His prescriptions must be both intelligent and intelligible.

The opportunities for giving this advice are far greater than for giving any drug or all drugs put together. For long before and for long after there is any drug indication, there exists the plain, imperative need of physical exercise, even for those in perfect health who desire to keep that blessing. Either physicians must recognize the growing demands for professional advice as to such means of maintaining health or a new profession will arise to keep people out of the doctors' hands. Even now doctors are called upon for this advice, and it is a great mistake to suppose that the call demands little attention.

The grandest opportunity for the introduction of this new system of gymnastics is in the schools, where succeeding generations are molded. According to statistics, in only three in a thousand of the public schools of this country is any attention paid to physical training. Even a casual inspection of these schools, where entire attention is paid to mental development, reveals sufficient reasons for the abounding deficiencies and deformities which make almost conspicuous any well-formed man or woman. To say nothing of the debilitating influence of their commonly wretched hygienic surroundings, their entire lack of physical exercise as a corrective for the unnatural sedentary life that is forced upon them is cause sufficient for their poor bodily development.

It is a popular fallacy that the short recesses and the after-school play-hours can make up for the long school-sessions, during which the children must sit still and too often in a necessarily cramped position. The school-yard is generally so small and crowded that only the bolder boys dare run in it; the timid, weakly boys and the girls dawdle away the precious minutes. And even the common sports of childhood do not furnish the right sort of exercise. Like that of tramping up the long stair-flights, and of going to and from the school, the exercise is mainly of the lower limbs, which in the unnatural conditions of civilization suffer least from disuse, and therefore stand in least need of artificial development. Invaluable as the play-hours are in relief from mental strain, the exercise thus afforded needs to be supplemented by such as will give the child the best possible body. Such exercise can easily be provided in the schools, and will be provided when parents awake to the fact that children's bodies as well as minds suffer from neglect, and become serviceable according to the care taken in their development.

WHY ARE WE RIGHT-HANDED?

By W. C. CAHALL, M. D.

THE reader has no doubt often wondered why people almost invariably use their right hand in preference to the left. Is it not remarkable that, through all time and in all lands, man has been a right-handed being? The individual exceptions only prove the rule. What is the reason? It can not be simply imitation or heredity, for in those children who are disposed to use the left hand these influences will not avail in changing the inclination, even, in many instances, when supplemented by persuasion or force.

In my belief, there is a physical cause for this uniform habit—a cause that is demonstrable by anatomical and physiological facts. These, for the sake of brevity, are expressed in the following statements:

1. The brain (cerebrum) is divided into two hemispheres.

2. The nerve-force and nerve-fibers which produce muscular action on the one side of the body have their origin in the opposite hemisphere of the brain.

3. The left hemisphere, from the earliest period, is larger and heavier than its counterpart, and the convolutions of gray matter—the reservoirs of nervous energy—are more numerous on this side than on the right.

1, 2, 3, aorta.
1. Ascending part of aorta.
2. Transverse part and arch of aorta.
3. Descending part of aorta.
4. Innominate artery.
5. Right subclavian artery.
6. Right common carotid artery.
7. Left common carotid artery.
8. Left subclavian artery.

4. This superior development of the left hemisphere as to weight, size, and richness of convolutions, may be attributed to a peculiar arrangement of the blood-vessels, by means of which a greater blood-supply is distributed to the brain-substance of this side.

5. The arrangement of the blood-vessels to which I refer is the manner of origin of the right and left common carotid arteries. The carotid artery is a branch of the innominate artery on the right side, while it springs direct from the aorta on the left.

This directness of communication, in addition to a larger caliber of the left carotid, gives the left hemisphere a decided advantage in the race of development.

To reverse these statements we would have: as a consequence of the greater capacity of the left carotid the left hemisphere of the brain has a greater blood-supply; as a consequence, there is a greater de-

velopment of the left hemisphere as to weight, bulk, and number of convolutions; as a consequence, when there is need of muscular action, the child naturally uses those muscles which possess the more powerful nerve-supply, for muscles are only strong in proportion to their nerve-supply; as a consequence, the nervous energy is dispatched, in those cases where there can be a choice, from the left hemisphere; as a consequence, the right hand and right leg will be the more likely used, since this side of the body is innervated by the left hemisphere. Thus, predisposition primarily, and use afterward, influencing and strengthening each other, fix upon us a habit almost unchangeable—how firmly, let those who ever attempted to break the habit in a left-handed boy testify.

But this leads to another question. Why are there left-handed people? Before we answer this question we will again look at the diagram. We have seen that, as the aorta rises from the heart, it arches from right to left, and the first large artery it gives off is the innominate, which in turn is divided into the right common carotid and right subclavian arteries. Farther on, we find the left common carotid and the left subclavian arteries arising separately from the aorta. Now, in making their dissections, anatomists have found that in a certain proportion of their subjects the aorta arches from left to right, in which cases the innominate is on the left side, and the common carotid and subclavian separate on the right. This arrangement would favor the growth of the right hemisphere, and would predispose to the use of the left hand.

Unfortunately, there have been no *post-mortem* examinations made for the purpose of observing whether this arrangement of blood-vessels and the use of the left hand really do occur in the same individual, nor is it necessary that it should be found in every case, for there are other anomalies in vessel-branching which would favor the growth of the right hemisphere. Apropos of speaking of the preponderance of the right over the left hemisphere, it might not be amiss to mention here that recent investigations have shown this condition of the brain to be characteristic of certain forms of insanity. This does not prove, however, that because a person is left-handed he is necessarily in any degree insane, as some *dexterous* reader may superciliously infer. Now, if the reason of our choice of a hand is due to an organic cause, how unwise is it to fight against nature, unless we commence at the beginning, and trust that habit will overcome the predisposition to the use of the left hand! Undertaken later, the result is often to spoil the skill of the left hand, without training the right to do its work as well. In conclusion, from what we have seen above, in answer to the question, Why are we right-handed? it might be said, because we are left-headed.

LENGTHENING THE VISIBLE SPECTRUM.

By JOHANNES GÖTZ.

THE phenomena of refraction and dispersion teach us that a body in a state of intensest heat emits not alone powerful thermal rays, but also all possible sorts of light (luminous colors). Diffraction convinces us that radiation is a wave-motion of an extremely fine, elastic, fluid medium, ether, and at the same time it enables us to compute the wave-length of the single rays. As is known, our apparatus suffices for taking cognizance of from one hundred and sixty to seven hundred and ninety billion undulations of heat or light per second, while all the vibrations of the ether lying either below or above are withdrawn from our direct observation. It is the purpose of this article to show what ways and means have been found for rendering the latter rays at least partly visible to our eye.

We throw a spectrum upon a white screen by means of a prism. The rays of the inferior number of undulations (ultra-red) will lie beyond the red, the superior (ultra-violet) beyond the violet end of the spectrum. We will begin with the latter.

We replace the screen, generally covered with ordinary white paper, by another one, the covering of which is impregnated with silver chloride, a combination of the two elements, chlorine and silver.* When the light has for some time operated upon this preparation, we interrupt it, and examine the screen by the light of a candle. We find that the coating has become blackened; that the blackening is insignificant at the place where we formerly had red light, but that it increases the nearer we approach toward the violet end; that it finally attains its maximum beyond this place, and gradually grows weaker until, at a certain distance, it disappears from the violet end. Whence this blackening? By the operation of the ether-waves, the combination of chlorine and silver was dissolved, the chlorine passed into the air in the form of vapor, while the silver was precipitated in microscopically fine pearls upon the paper. The coating became black, because silver is not metallically lustrous in such minute division, but simply constitutes a black powder.

This experiment convinces us that rays will still be found beyond the violet end of the spectrum, which, on account of their high number of undulations, are shrouded from our sight, and yet betray their presence by the decomposition of silver preparations. These rays have been called *actinic* or *chemical rays*, and their spectrum the *chemical spectrum*.

* This and most of the following experiments succeed well only with a very great power of light. It is necessary, therefore, to sustain the lamp by a battery of from sixty to eighty elements. In the present case, sixty-four large Bunsen elements were employed.

Our proposition is, "May not these rays, even if only partially, be rendered visible to the eye?" Let us, for this purpose, shut out all the other vividly luminous colors of the spectrum, so that they shall not interfere, by their excess of illumination, with the feeble effect of the ultra-violet rays. We interpose a black screen in their path, and cut off all except the extreme violet ones. The ultra-violet rays now become visible upon the white screen;* we see them of a feebly lustrous lavender-gray.

This method of rendering the ultra-violet rays visible is extremely primitive. Stokes, the successor of the great Newton in the professor's chair of the University of Cambridge, indicated a means by which our object is attained much more effectively. He introduced a piece of calcic fluoride into the ultra-violet part of the spectrum, and found that this crystal began to shine brightly with a blue light. Before we attempt to elucidate this peculiarity, however, let us consider the influence of the motion of ether upon a body.

When a ray arrives upon the surface of a body, three things may be imagined: The ray is either reflected, or it is transmitted, or absorbed. We describe the first two cases as reflection and refraction. In the third case, the ray is absorbed, and serves for heating the body, which itself emits again the arriving motion of ether in the form of calorific rays.† Besides these three cases, another, a fourth one, is possible, to wit, that, although the arriving rays are absorbed, they are not wholly employed in the heating of the body, but are partly altered into rays of another number of waves, and are emitted again under their changed form. Stokes, who first investigated this alteration more minutely, named it fluorescence.

Investigations demonstrate that, besides the calcic fluoride, there are an entire series of fluid substances possessing this property of conversion: for instance, petroleum; again, the solution of the highly esteemed febrifuge—quinine sulphate; esculine, an extract of the bark of the common horse-chestnut; leaf-green, or chlorophyl; eosine, frequently used in the manufacture of red ink; and, finally, in a high degree, the solution of a substance discovered by Bayer, of Munich, fluoresceine (resorcinphtaline).

Let us get better acquainted with these fluorescing substances. Best for this purpose is a narrow glass tube, filled with rarefied air—a so-called Geissler's tube, surrounded by an envelope, containing solutions of such substances in four divisions (Fig. 1).

By means of the electric current we bring the inclosed air to a red heat. It emits whitish-violet light, which penetrates into the fluorescing solutions, and is by them partly transmitted and partly absorbed.

* In this experiment, the screen, impregnated with silver chloride, was replaced by a white one.

† The name of calorescence would be far more applicable to this peculiarity than to the one mentioned further below.

We find the transmitted light to be colored differently by the different fluids, but that these latter themselves begin to shine in different colors—for instance, eosine, green; quinine sulphate, blue. By the former, the transmitted light is red; by the latter, almost white. In both cases, consequently, the rays emanating from the red-hot gas were screened as it were, and the retained part converted into rays of another number of undulations, to wit, into green with eosine, and blue with quinine.

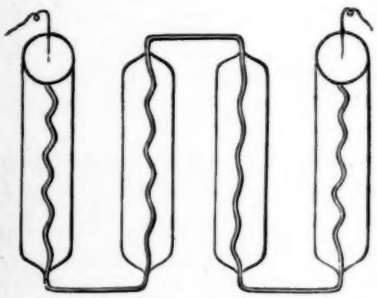

Fig. 1.

Far more intense and admirable in color become the appearances, when we make the powerful rays of the electric light parallel by means of a condensing lens, pass them through a square glass vessel filled with pure water, and to this add the substances by drops. We will begin with eosine. We pour a little of the solution into the water, and an admirable, vividly green-colored cloud at once spreads within the vessel. If we place a white screen behind the vessel, we find that the transmitted light appears red upon it. Eosine, consequently, possesses the property of only permitting the red rays to pass, and of altering them into green light, while absorbing all the others. We take fresh water, and repeat the experiment with fluoresceine. The green of the generated cloud now is far more vivid, while the transmitted light is yellow. We close the experiments with quinine sulphate. The cloud is colored delicately blue, but the transmitted light is pure white. Which rays were absorbed in this case? A later experiment will answer the question.

There is an occurrence very generally found in nature which is dissimilar in form, but analogous in essence, with the fluorescence. With fluorescent substances, the emission of light ceases as soon as illumination is interrupted. If light is thrown upon calcium preparations, a part of the rays is also absorbed, and altered into rays of another number of waves. But these preparations emit the absorbed rays partly only after the cessation of illumination. Owing to the weakness of the light emitted, it becomes visible only ofter the preparations have been placed in darkness. Since this peculiarity of subsequent illumination is analogous to the development of light occurring when a piece of phosphorus is rubbed in darkness, it has been called phosphorescence. Both the duration and intensity of this subsequent light depend upon the nature of the substances employed. There are those known, the light of which disappears very quickly after its emission, and again those by which the illumination lasts as long as eighteen hours—of course, while growing constantly feebler.

For the study of this phosphorescence we again make use of a

Geissler's tube, the exterior envelope of which contains four phosphorescent substances in four divisions (Fig. 2). By means of the electric current, we raise the temperature of the inclosed air to a glow-heat, and cause the emitted rays of light to operate for about a minute upon calcium salts.

FIG. 2.

After interrupting the light, the salts appear in four different colors, to wit: orange, yellow, green, and blue. This property of phosphorescence is universally found in nature. I call to mind the glowing of decayed wood, that of fire-bugs, etc. Various inferior organisms are provided with special glands for secreting phosphorescent substance. During excitement this is exuded by the animal, and begins to emit light. The phosphorescent light of the tropical waters is produced by myriads of minute organisms, by which the substance is secreted.

An Englishman, Balmain, succeeded some time ago in manufacturing a substance of a fairly intense and durable phosphorescence. It is used for painting watch-dials, match-boxes, door-signs, etc., to make them self-illuminating. In tenor with the nature of things, these articles can discharge their functions only after they have previously been exposed to the light of day, or some other energetic source of light.

We have in this manner become acquainted with means of altering rays of one number of waves into those of another number, and we will employ these means of rendering the ultra-violet rays visible to the eye. For this purpose, we must seek for substances possessing the property of absorbing these ultra-red rays, in order to emit them as rays of an inferior number of undulations. Besides the calcic fluoride, the above-named solutions of quinine sulphate and of esculine will answer our purpose.

We again throw a spectrum in the above-described manner, and introduce a calcic fluoride crystal into the ultra-violet part. It begins at once to shine vividly with a blue light. A writing with cyanuret of barium and platinum upon white paper is invisible in ordinary white light, but, as soon as we expose it in the ultra-violet end of the spectrum, it emits greenish-blue light. Finally, if we throw the spectrum upon a screen, the paper covering of which is saturated with quinine sulphate, we shall at once observe that it extends largely beyond the violet end. The ultra-violet rays now begin to appear with a pale-blue color. By the operation upon the quinine sulphate, therefore, the invisible rays have been converted into visible, illuminating ones.

Deeply violet-colored glass possesses the property of transmitting only the extreme violet and ultra-violet rays, and absorbing all the others. We cause a pencil of white luminous rays to emanate from the incandescent carbon-points of an electric light, which, rendered

parallel through a condensing lens, passes through a square glass vessel containing clear water. We introduce a pane of violet glass into its path. The illuminating radiation is cut off by it, and only a few violet rays are transmitted. The ultra-violet ones, however, are represented much more abundantly in the now invisible pencil. Their existence is revealed at once when we add a few drops of the quinine solution to the water. Bright blue-colored clouds now move within the vessel, generated by the quinine absorbing the ultra-violet rays and changing them into blue light. The appearance becomes still brighter by substituting the more energetic fluorescent esculine in place of the quinine.

If we draw a sketch * upon yellow paper with an esculine solution, it is invisible in daylight as well as by electric light. But if we insert the violet glass into the pencil-cone, the single parts of the picture begin to shine vividly with a blue light. The sketch flames up at once in the obscurity before our eye, and we might imagine that we have been transported into Fairy-land.

We have until now had our attention engaged with the ultra-violet rays; it remains to speak of their practical adaptation. On account of their chemical effect upon the salts of silver, they constitute the basis of an important branch of industry—photography. As we have seen above, the red rays have almost no influence upon such preparations, while the effect of the yellow and green ones, when compared to that of the blue, violet, and ultra-violet, is not very great. Many mysteries of photography, incomprehensible to the layman, are explained hereby. A red and a black dress, for instance, are exactly alike upon a photograph, while blue and white, in their effect, approach nearer to white.

We now turn to the opposite end of the spectrum—the ultra-red rays. Our proposition is, "Are we able to render perceptible to the eye, the organ of sight, those rays that operate upon our sense of feeling simply as conveyers of heat?" We can attain our purpose only by augmenting the number of vibrations the thermal rays, by their influence upon suitable bodies, in such a manner that they are rendered perceptible to the visual organ. We provide the electric lamp with a parabolic reflector, A B, silvered and polished within, with incandescent carbon-points in its focus. The intense rays of the lamp are made parallel by the reflector, and pass through the room as a bright horizontal column. We recognize their course by the illuminated dust-particles of the air. We interpose another spherical reflector, C D, also silvered and polished, in the course of the rays. According to the law of reflection, all the rays falling upon the latter unite into one point, the focus (Fig. 3). It is easily recognized, since it brightly illuminates the dust-particles of the air. But not

* The one employed by Mr. W. Fried, of Augsburg, represents a Renaissance ornamentation, of about sixty centimetres in diameter.

alone the luminous, but also the thermal rays, are united at this point. We become convinced of this fact by holding a cigar at the focus: it is at once ignited, begins to smoke, and bursts into flame. In consequence of the concentration of the caloric rays, the most varied inflammable bodies may be ignited at this luminous point. Paper is perforated and charred in a moment, zinc consumes with a bright violet flame. Very thin, blackened platinum is brought to a white heat, and emits an intense white light. We place a test-tube filled with water within the focus; it begins at once to burst into bubbles, and commences to boil. Are these observed occurrences effected by the rays of heat or of light, emanating from the incandescent carbon-points? We answer this question by placing a body in the course of the rays, which, although it transmits the luminous rays, absorbs the thermal ones. Such a one is a concentrated solution of alum in water. We place a glass vessel, filled with this perfectly transparent solution, between the two reflectors, and in this manner sift the rays emanating from the carbon-points. The luminous focus is still there, but the ebullition of the water in the test-tube ceases at once. We remove the vessel, and ebullition is resumed with violence. Those rays, therefore, that caused the boiling were absorbed by the alum solution. This had meanwhile been raised in temperature, and, if left sufficiently long, it would begin to boil. We return the solution into the path of the rays, and place white paper within the focus. It is illumined brightly, but not consumed. We repeat the experiment with gun-cotton wrapped in white paper. It might lie there for a hundred years without exploding. We remove the vessel, and explosion occurs at once. We continue the experiment with black paper, by bringing it into the focus of the rays sifted through the solution, when it is at once perforated and ignited. Gun-cotton wrapped in black paper explodes almost instantly. Why is it that the same rays that left white paper intact at once ignite black? The luminous radiation transmitted by the solution is not absorbed, but reflected, by the white paper. It is brightly illumined, but not heated. Black paper, however, absorbs these rays, is heated thereby, and ignites.

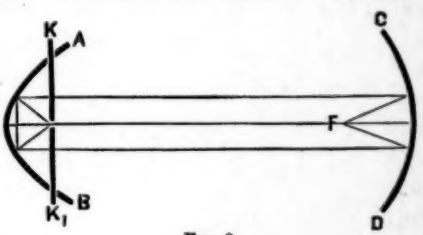

FIG. 3.

The preceding experiments convince us that the combustion and heating of bodies in the focus are solely caused by the dark rays emitted by the carbon-points. We confirm this conviction by introducing into the path of the rays a body transmitting the dark radiation with the greatest facility, while completely absorbing the luminous one. According to Tyndall's experiments, this condition is complied with to a very high degree by a solution of iodine in carbonic disulphide.

We introduce a very thin-walled glass cell, filled with such a solution, between the reflectors. Light is now cut off, but heat passes through freely. The focus is absolutely dark, but it still contains heat, of which fact we can soon convince ourselves by introducing a cigar into it: it is ignited and bursts into flame. White as well as black paper is charred and ignites in it. A piece of platinum-foil is raised to white heat in the dark focus. If we examine the incandescent platinum with a prism, we find that it emits again all colors, from the most extreme red to the most extreme violet; consequently, we have here the counterpart of fluorescence. The dark rays, by the augmentation of the number of vibrations, are converted into luminous ones, influencing the eye. Tyndall, who first observed and examined this appearance, called the conversion calorescence.

We have thus passed through a domain of physics, the more exact knowledge of which we mainly owe to the researches of our century, more especially to very recent times. That part of radiation perceptible to our organs of sense was extended far beyond the violet end of the spectrum, in investigating the chemical effects of light and fluorescence. We succeeded at the same time in rendering visible that part simply felt by the eye. It can not for a moment be supposed that there are no more rapid or slow rays, besides those already known to us, and ranging in the number of vibrations from one hundred and sixty to two thousand billions. Their existence can just as little be doubted as that of the ultra-violet. Whether we shall ever succeed in rendering them perceptible to our organs of sense remains a task for the investigations of the future. — *Westermann's Monatshefte.*

THE BOUNDARIES OF ASTRONOMY.

I.

IS GRAVITATION UNIVERSAL?

By ROBERT S. BALL,
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IT is proposed in this and the following paper to trace some parts of the boundary-line which divides the truths which have been established in astronomy from those parts of the science which must be regarded as more or less hypothetical. It will be obvious that only a small part of so wide a subject can be discussed, or even alluded to, in the limits proposed. We intend, therefore, to select certain prominent questions, and to discuss those questions with such fullness as the circumstances will admit.

It will be desirable to commence with that great doctrine in astronomy which is often regarded as almost universally established.

The doctrine to which we refer is known as the law of universal gravitation. It is customary to enunciate this law in the proposition that every particle of matter attracts every other particle with a force which varies directly as the product of the masses and inversely as the square of their distance. It is no doubt convenient to enunciate the great law in this very simple manner. It might seem awkward to have to specify all the qualifications which would be necessary if that enunciation is to assert no more than what we absolutely know. Perhaps many people believe, or think they believe, the law to be true in its general form; yet the assertion that the law of gravitation is *universally* true is an enormous, indeed, an infinite, exaggeration of the actual extent of our information.

To make this clear, let us contrast the law of gravitation as generally stated with the proposition which asserts that the earth rotates on its axis. No one who is capable of understanding the evidence on the question can doubt that the earth really does rotate upon its axis. I purposely set aside any difficulties of a quasi-metaphysical character, and speak merely of words in their ordinary acceptation. In stating that the earth rotates upon its axis, we assert merely a definite proposition as regards one body, all the facts which the assertion involves are present to our minds, and we know that the assertion must be true. Equally conclusive is the evidence for the statement that the earth revolves around the sun. Concrete truths of this kind could be multiplied indefinitely. We can make similar assertions with regard to the planets. We can assert that the planets rotate upon their axes, and that the planets revolve around the sun. But the law of gravitation is a proposition of quite a different nature. Let us examine briefly the evidence by which this law has been established.

The science of dynamics is founded upon certain principles known as the laws of motion. The simplest of these principles asserts that a body, once set moving in a straight line, will continue to move on uniformly forever in the same straight line, unless some force be permitted to act upon that body. For nature as we know it, this law seems to be fully proved. It has been tested in every way that we have been able to devise. All these tests have tended to confirm that law. The law is therefore believed to be true, at all events throughout the regions of space accessible to us and to our telescopes. Assuming this law and the other principles analogous to it, we can apply them to the case of the revolution of the earth around the sun. As the earth is not moving in a straight line, it must be acted upon by some force. It can be shown that this force must be directed toward the sun. It will further appear that the intensity of this force will vary inversely as the square of the distance between the earth and the sun. The movements of the planets can be made to yield the same conclusions. All these movements can be accounted for on the supposition that each planet is attracted by the sun with a force which

varies directly as the product of the masses, and inversely as the square of the distance between the two bodies. When more careful observations are introduced, it is seen that the planets exhibit some slight deviations from the movements which they would have were each planet only acted upon by the attraction of the sun. These deviations do not invalidate the principle of attraction. They have been shown to arise from the mutual attractions of the planets themselves. Each of the planets is thus seen to attract each of the other planets. The intensity of this attraction between any pair of the planets is proportional to the masses of these planets, and varies inversely as the square of the distance between them. We may use similar language with regard to the satellites by which so many of the planets are attended. Each satellite revolves around its primary. The movements of each satellite are mainly due to the preponderating attraction of the primary. Irregularities in the movements of the satellites are well known to astronomers, but these irregularities can be accounted for by the attraction of other bodies of the system. The law of attraction thus seems to prevail among the small bodies of the system as well as among the large bodies. It is true that there are still a few outstanding discrepancies which can not yet be said to have been completely accounted for by the principle of gravitation. This is probably due to the difficulties of the subject. The calculations which are involved are among the most difficult on which the mind of man has ever been engaged. We may practically assume that the law of gravitation is universal between the sun, the planets, and the satellites; and we may suppose that the few difficulties still outstanding will be finally cleared away, as has been the case with so many other seeming discrepancies. But even when these admissions have been made, are we in a position to assert that the law of gravitation is universal throughout the solar system? We are here confronted with a very celebrated difficulty. Do those erratic objects known as comets acknowledge the law of gravitation? There can be no doubt that in one sense the comets do obey the law of gravitation in a most signal and emphatic manner. A comet usually moves in an orbit of very great eccentricity; and it is one of the most remarkable triumphs of Newton's discovery, that we were by its means able to render account of how the movements of a comet could be produced by the attraction of the sun. As a whole, the comet is very amenable to gravitation, but what are we to say as to the tails of comets, which certainly do not appear to follow the law of universal attraction? The tails of comets, so far from being attracted toward the sun, seem actually to be repelled from the sun. Nor is even this an adequate statement of the case. The repulsive force by which the tails of the comets are driven from the sun is sometimes a very much more intense force than the attraction of gravitation.

I have no intention to discuss here the vexed question as to the

origin of the tails of comets. I do not now inquire whether the repulsion by which the tail is produced be due to the intense radiation from the sun, or to electricity, or to some other agent. It is sufficient for our present purpose to note that, even if the tails of comets do gravitate toward the sun, the attraction is obscured by a more powerful repulsive force.

The solar system is a very small object when viewed in comparison with the dimensions of the sidereal system. The planets form a group nestled up closely around the sun. This little group is separated from its nearest visible neighbors in space by the most appalling distances. A vessel in the middle of the Atlantic Ocean is not more completely isolated from the shores of Europe and America than is our solar system from the stars and other bodies which surround it in space. Our knowledge of gravitation has been most entirely obtained from the study of the bodies in the solar system. Let us inquire what can be ascertained as to the existence of this law in other parts of the universe. Newton knew nothing of the existence of the law of gravitation beyond the confines of the solar system. A little more is known now.

Our actual knowledge of the existence of gravitation in the celestial spaces outside the solar system depends entirely upon those very interesting objects known as binary stars. There are in the heavens many cases of two stars occurring quite close together. A well-known instance is presented in the star Epsilon Lyræ, where two stars are so close together that it is a fair test of good vision to be able to separate them. But there are many cases in which the two stars are so close together that they can not be seen separately without the aid of a telescope. We may take, for instance, the very celebrated double star Castor, well known as one of the Twins. Viewed by the unaided eye, the two stars look like a single star, but in a moderately good telescope it is seen that the object is really two separate stars quite close together. The question now comes as to whether the propinquity of the two stars is apparent or real. It might be explained by the supposition that the two stars were indeed close together compared with the distance by which they are separated; or it could be equally explained by supposing that the two stars, though really far apart, yet appeared so nearly in the same line of vision that when projected on the surface of the heavens they seemed close together. It can not be doubted that in the case of many of the double stars, especially those in which the components appear tolerably distant, the propinquity is only apparent, and arises from the two stars being near the same line of vision. But it is, also, undoubtedly true that in the case of very many of the double stars, especially among those belonging to the class which includes Castor, the two stars are really at about the same distance from us, and, therefore, as compared with that distance, they are really close together.

Among the splendid achievements of Sir William Herschel, one of the greatest was his discovery of the movements of the binary stars. It was shown by Herschel that in some of the double stars one star of the pair was moving around the other, and that their apparent distances were changing. The discoveries inaugurated by Herschel have been widely extended by other astronomers. One of the more rapidly moving of the double stars lies in the constellation of Coma Berenices. The revolution of one component around the other requires a period of 25·7 years. The two components of this star are exceedingly close together, the greatest distance being about one second of arc. There is very great difficulty in making accurate measurements of a double star of which the components are so close. More reliance may consequently be placed upon the determination of the orbits of other binary stars of which the components are farther apart. Among these we may mention the remarkable binary star ξ Ursæ Majoris. The distance between the two components of this star varies from one second of arc to three seconds. The first recorded measurement of this object was by Sir William Herschel, in 1781, and since that date it has been repeatedly observed. From a comparison of all the measurements which have been made it appears that the periodic time of the revolution of one of these components about the other is about sixty years. This star has thus been followed through more than one entire revolution. The importance of these discoveries became manifest when an attempt was made to explain the movements. It was soon shown that the movements of the stars were such as could be explained if the two stars attracted each other in conformity with the law of gravitation. It would, however, be hardly correct to assert that the discovery of the binary stars proved that the two stars attracted each other with a force which varies inversely as the square of their distance. Even under the most favorable circumstances the observations are very difficult; they can not be made with the same accuracy as is attained in observing the movements of the planets; they have not even the value which antiquity will often confer on an observation which has not much else in its favor. There are probably many different suppositions which would explain all that has yet been observed as to the motions of the binary stars. Gravitation is but one of those suppositions. Gravitation will no doubt carry with it the prestige acquired by its success in explaining phenomena in the solar system. I do not know that any one has ever seriously put forward any other explanation except gravitation to account for the movements of the binary stars, nor is any one likely to do so while gravitation can continue to render an account of the observed facts; but all this is very different from saying that the discovery of the binary stars has *proved* that the law of gravitation extends to the stellar regions.

Except for what the binary stars tell us, we would know nothing as to the existence or the non-existence of the law of gravitation beyond

the confines of the solar system. Does Sirius, for instance, attract the pole-star? We really do not know. Nor can we ever expect to know. If Sirius and the pole-star do attract each other, and if the law of their attraction be the same as the law of attraction in the solar system, it will then be easy to show that the effect of this attraction is so minute that it would be entirely outside the range of our instruments even to detect it. Observation is hopeless on such a matter. If we can not detect any attraction between a star in one constellation and a star in another, no more can we detect any attraction between our sun and the stars. Such attractions may exist, or they may not exist: we have no means of knowing. Should any one assert that there is absolutely no gravitation between two bodies more than a billion miles apart, we know no facts by which he can be contradicted.

If we know so little about the existence of gravitation in the space accessible to our telescopes, what are we to say of those distant regions of space to which our view can never penetrate? Let a vast sphere be described of such mighty dimensions that it embraces not only all the objects visible to the unaided eye, not only all the objects visible in our most powerful telescopes, but even every object that the most fertile imagination can conceive, what relation must this stupendous sphere bear to the whole of space? The mighty sphere can only be an infinitely small part of space. It must bear to the whole of space a ratio infinitely less than the water in a single dew-drop bears to the water in the Atlantic Ocean. Are we then entitled to assert that every particle in the universe attracts every other particle with a force which is proportional to the product of their masses, and which varies inversely as the square of their distance? We have, indeed, but a slender basis of fact on which to rest a proposition so universal. Let us attempt to enunciate the law of gravitation so as to commit ourselves to no assertion not absolutely proved. The statement would then run somewhat as follows:

Of the whole contents of space we know nothing except within that infinitely small region which contains the bodies visible in our telescopes. Nor can we assert that gravitation pervades the entire of even this infinitely small region. It is true that in one very minute part of this infinitely small region the law of gravitation appears to reign supreme. This minute part is of course the solar system. There are also a few binary stars in this infinitely small region whose movements would admit of being explained by gravitation, though as yet they can hardly be held to absolutely prove its existence.

It must then be admitted that, when the law of gravitation is spoken of as being universal, we are using language infinitely more general than the facts absolutely warrant. At the present moment we only know that gravitation exists to a very small extent in a certain indefinitely small portion of space. Our knowledge would have to be enormously extended before we can assert that gravitation extended

entirely through this very limited region; and, even when we have proved this, we should have only made an infinitesimal advance to a proof that gravitation is absolutely universal.

I do not for a moment assert that our ordinary statement of the law of gravitation is untrue. I merely say that it has not been proved, and we may also add that it does not seem as if it ever could be proved. Most people who have considered the matter will probably believe that gravitation is universal. Nor is this belief unnatural. If we set aside comets' tails, and perhaps one or two other slightly doubtful matters, we may assert that we always find the law of gravitation to be true whenever we have an opportunity of testing it. These opportunities are very limited, so that we have but very slender supports for the induction that gravitation is universal. But it must be admitted that an hypothesis which has practically borne every test which can be applied has very strong grounds for our acceptance: such, then, are the claims of the law of gravitation to be admitted to a place among the laws of Nature.

The wondrous series of spectroscopic researches by which Mr. Huggins has so vastly extended our knowledge should also be here referred to. Mr. Huggins has shown that many of the substances most abundant on the earth are widely spread through the universe. Take, for instance, the metal iron and the gas hydrogen. We can detect the existence of these elements in objects enormously distant. Both iron and hydrogen exist in many stars, and hydrogen has been shown, in all probability, to be an important constituent of the nebulæ. That the rest of the sidereal system should thus be composed of materials known to be to a large extent identical with the materials in the solar system is a presumption in favor of the universality of gravitation.

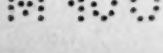
In what has hitherto been said, we have attempted to give an outline of the facts so far as they are certainly known to us. Into mere speculations we have no desire to enter. We may, however, sketch out a brief chapter in modern sidereal astronomy, which seems to throw a ray of light into the constituents of the vast abyss of space which lies beyond the scope of our telescopes. The ray of light is no doubt but a feeble one, but we must take whatever information we can obtain, even though it may fall far short of that which an intellectual curiosity will desire. The question now before us may be simply stated: Are we entitled to suppose that the part of the universe accessible to our telescopes is fairly typical of the other parts of the universe, or are we to believe that the system we know is altogether exceptional; that there are stars in other parts quite unlike our stars, composed of different materials, acted upon by different laws, of which we have no conception? The presumption is, that the materials of which our system is composed are representative of the materials elsewhere. This presumption is strengthened by the very important considerations now to be adduced.

In the first place, let us distinctly understand what is meant by our sidereal system. We have already dwelt on the isolated position of the sun and the attendant planets. The grandest truth in the whole of astronomy is that which asserts that our sun is only a star separated by the most gigantic distances from the other stars around. Our sun, indeed, appears to be but one of the vast host of stars which form the milky way. We need not here enter into the often-discussed question as to whether the nebulæ are, generally speaking, at distances of the same order as the stars. There seems to be no doubt that some of the nebulæ are quite as near to us as some of the stars. At all events, for our present purpose, we may group the milky way, the nebulæ, the stars, and the clusters, all into one whole which we call our sidereal system. Is this sidereal system as thus defined an isolated object in space? are its members all so bound together by the law of universal gravitation that each body, whatever be its movements, can only describe a certain path such that it can never depart finally from the system? This is a question of no small importance. It presents features analogous to certain very interesting problems in biology which the labors of Mr. Wallace have done so much to elucidate. We are told that the fauna and flora of an oceanic island, cut off from the perpetual immigration of new forms, often assumes a very remarkable type. The evolution of life under such circumstances proceeds in a very different manner to the corresponding evolution in an equal area of land which is connected with the great continental masses. Is our sidereal system to be regarded as an oceanic island in space, or is it in such connection with the systems in other parts of space as might lead us to infer that the various systems had a common character?

The evidence seems to show that the stars in our system are probably not permanently associated together, but that in the course of time some stars enter our system and other stars leave it, in such a manner as to suggest that the bodies visible to us are fairly typical of the general contents of the universe. The strongest evidence that can be presented on this subject is met with in the peculiar circumstances of one particular star. The star in question is known as No. 1830 of Groombridge's catalogue. It is a small star, not to be seen without the aid of a telescope. This star is endowed with a very large proper motion. It would not be correct to say that its proper motion exceeds that of any other known star, but it certainly has the largest visible proper motion of any star of which the distance is known. The proper motion of 1830 Groombridge amounts to over seven seconds annually. It would take between two and three centuries to move over a distance in the heavens equal to the apparent diameter of the moon. The distance of this star is much greater than might have been anticipated from its very large proper motion. The estimates of the distance present some irregularities, but we shall probably be

quite correct in assuming that the distance is not less than two hundred billions of miles. This star is, indeed, ten times as far from us as *a* Centauri, which is generally considered to be the sun's nearest neighbor in our sidereal system. The proper motion and the distance of 1830 Groombridge being both assumed, it is easy to calculate the velocity with which that star must be moving. The velocity is indeed stupendous and worthy of a majestic sun ; it is no less than 200 miles a second. It would seem that the velocity may even be much larger than this. The proper motion of the star which we see is merely the true proper motion of the star foreshortened by projection on the surface of the heavens. In adopting 200 miles a second as the velocity of 1830 Groombridge, we therefore make a most moderate assumption, which may and probably does fall considerably short of the truth. But, even with this very moderate assumption, it will be easy to show that 1830 Groombridge seems in all probability to be merely traveling through our system, and not permanently attached thereto.

The star sweeps along through our system with this stupendous velocity. Now, there can be no doubt that if the star were permanently to retain this velocity, it would in the course of time travel right across our system, and, after leaving our system, would retreat into the depths of infinite space. Is there any power adequate to recall this star from the voyage to infinity? We know of none, unless it be the attraction of the stars or other bodies of our sidereal system. It therefore becomes a matter of calculation to determine whether the attraction of all the material bodies of our sidereal system could be adequate, even with universal gravitation, to recall a body which seems bent on leaving that system with a velocity of 200 miles per second. This interesting problem has been discussed by Professor Newcomb, whose calculations we shall here follow. In the first place, we require to make some estimate of the dimensions of the sidereal system, in order to see whether it seems likely that this star can ever be recalled. The number of stars may be taken at one hundred million, which is probably double as many as the number we can see with our best telescopes. The masses of the stars may be taken as on the average five times as great as the mass of the sun. The distribution of the stars is suggested by the constitution of the milky way. One hundred million stars are presumed to be disposed in a flat, circular layer of such dimensions that a ray of light would require thirty thousand years to traverse one diameter. Assuming the ordinary law of gravitation, it is now easy to compute the efficiency of such an arrangement in attempting to recall a moving star. The whole question turns on a certain critical velocity of twenty-five miles a second. If a star darted through the system we have just been considering with a velocity less than twenty-five miles a second, then, after that star had moved for a certain distance, the attractive power of the system would gradually bend the path of the star round, and force the star to return to the system.



If, therefore, the velocities of the stars were under no circumstances more than twenty-five miles a second, then, supposing the system to have the character we have described, that system might be always the same. The stars might be in incessant motion, but they must always remain in the vicinity of our present system, and our whole sidereal system might be an isolated object in space, just as our solar system is an isolated object in the extent of the sidereal system. We have, however, seen that for one star at all events the velocity is no less than 200 miles a second. If this star dash through the system, then the attractions of all the bodies in the system will unite in one grand effort to recall the wanderer. This attraction must, to some extent, be acknowledged; the speed of the wanderer must gradually diminish as he recedes into space; but that speed will never be lessened sufficiently to bring the star back again. As the star retreats farther and farther, the potency of the attraction will decrease; but, owing to the velocity of the star being over twenty-five miles a second, the attraction can never overcome the velocity; so that the star seems destined to escape. This calculation is of course founded on our assumption as to the total mass of the stars and other bodies which form our sidereal system. That estimate was founded on a liberal, indeed, a very liberal interpretation of the evidence which our telescopes have afforded. But it may still fall short of the truth. There may be more than a hundred million stars in our system: their average weight may be more than five times the weight of our sun. But, unless the assumption we have made is enormously short of the truth, our inference can not be challenged. If the stars are sixty-four times as numerous, or if the whole mass of the system be sixty-four times as great as we have supposed, then the critical velocity would be 200 miles a second instead of twenty-five miles a second. Our estimate of the system would therefore have to be enlarged sixty-four-fold, if the attraction of that system is to be adequate to recall 1830 Groombridge. It should also be recollected that our assumption of the velocity of the star is very moderate, so that it is not at all unlikely that a system at least one hundred times as massive as the system we have supposed would be required if this star was to be recalled. The result of this inquiry is really only to be stated as an alternative: either our sidereal system is not an entirely isolated object, or its bodies must be vastly more numerous or more massive than even our most liberal interpretation of observations would seem to warrant. It seems more reasonable to adopt the first branch of the alternative. If this be so, then we see that 1830 Groombridge, having traveled from an indefinitely great distance on one side of the heavens, is now passing through our system for the first and the only time. After leaving our system this star will retreat again into the depths of space, to a distance which, for anything we can tell, may be practically regarded as infinite. Although we have only used this one star as an illustration, yet it is not to be

supposed that the peculiarities which it presents are absolutely unique. It seems more likely that there may be many other stars which are at present passing through our system. In fact, considering that most or all of the stars are actually in motion, it can be shown that, in the course of ages, the whole face of the heavens is gradually changing. We are thus led to the conclusion that our system is not an absolutely isolated group of bodies in the abyss of space, but that we are visited by other bodies coming from the remotest regions of space.—*Contemporary Review.*

ON BRAIN-WORK AND HAND-WORK.

By R. M. N.

DR. BEARD'S treatise on the "Longevity of Brain-Workers" was ably reviewed some years ago in the "Journal of Science." Still it appears to me that the last word on this topic has not yet been said. Certain points, both of distinction and of resemblance, seem to have been overlooked as well by reviewer as by author, and certain of the conclusions drawn are at least open to question.

I may perhaps be allowed to put the opening question, What is work? The common reply is, "Any pursuit by which a man earns or attempts to earn a livelihood and to accumulate wealth." This definition is the more to be regretted because it cherishes, or rather begets, the vulgar error that all persons who do not aim at the accumulation of wealth are "idlers." In point of fact such men may be doing far greater services to the world than the most diligent and successful votary of a trade or a profession. Darwin, having a competency, was therewith content. To him, and to others of kindred minds, the opportunity of devoting his whole life to the search after scientific truth was a boon immeasurably higher than any conceivable amount of wealth. Shall we call him an idler? Nor is science the only field which opens splendid prospects to men of independent means. Art, literature, philanthropy, have all their departments, unremunerative in a commercial point of view, or at least not directly remunerative, and for all these cultivators are wanted. Therefore, reversing the advice given by routine moralists, I would say to wealthy young men of ability: "Do not take up any trade, business, or profession, but do some of the world's unpaid work. Leave money-making to those who have no other option, and be searchers for truth and beauty." Every one who follows this advice will contribute something to show the world that the race for wealth is not the only pursuit worthy of a rational being. I should define work as the conscious systematic application of mind or body to any definite purpose.

I said "of mind or body." Perhaps the expression may sound old-

fashioned; so, to avoid grating on the nerves of a monistic world, I will say "of brain or muscle." But can we draw a sharp, well-defined boundary-line between brain-work and muscle-work? Recent investigations into the functions of the brain show that it has the task of directing and co-ordinating muscular effort. The athlete, or say the musical performer, has not merely to strengthen his muscles and acquire flexibility of arm, hand, and finger; his exercises serve at the same time to develop and perfect those regions of the brain by which the muscles in question are actuated and co-ordinated.

Professor Du Bois-Reymond, in his admirable articles on "Exercise" ("Popular Science Monthly" for July and August, 1882), contends that "bodily exercises are not merely muscle-gymnastics, but also nerve-gymnastics," and that practice in the movements of the limbs is "essentially exercise of the central nerve-system." Hence muscle-work which is not at the same time brain-work is a chimera, which has no existence. But it will now be asked, Is there any brain-work without muscle-work? Undoubtedly; we may see phenomena, we may reason upon them, and come to a conclusion concerning their nature without any muscular action at all. But if we even wish to write down our results, or to tell them to a friend, some muscular action, small though it be, is needed. Or we wish to go further: not content with merely observing the phenomena which chance brings before our eyes, we go forth in search of facts. Here muscular-work is blended with brain-work. A step further: We wish to put definite questions to Nature, to perform physical, chemical, or physiological experiments. In all these cases the hand has to be the inseparable companion of the brain. The efficiency of the one will not compensate for inefficiency in the other. Now, the work of the experimentalist rarely requires great strength, but it invariably stands in need of delicacy, nicety of touch and movement, bodily or, if you will, muscular, attributes to be reached only by training.

It is the same in the fine arts. The painter needs not merely an exquisite perception of form and color, an instinctive—as it appears to outsiders—appreciation of their relations and harmonies; unless he possesses in addition to all this the requisite nicety of touch, he must fail to embody in visible form the conceptions present in his brain. Precisely the same is it with the musician. The orator and the actor must also, in addition to their mere mental gifts, have vocal organs thoroughly developed and disciplined. Thus we see that in the highest walks of science and art, brain-work and muscle-work exist, I might say, in a state of interpenetration.

Again, at a work-table in Y—— Street sits a microscopist, carefully studying the peculiarities of a newly detected microbion, or dissecting the larva of the Phylloxera. What is he? Brain-worker, or muscle-worker? You pronounce him a brain-worker; his brain, in your opinion, doing the larger—the essential—part of his task. So be

it. I convey you to X—— Street, where at another work-table sits a microscope-maker. He is accurately adjusting an objective of high power. What is he? Like the user of the microscope just mentioned, he requires the utmost delicacy of touch, the highest manipulative skill. Like the microscopist, also, his brain performs the essential part of the task. But you will probably call him a hand-worker or muscle-worker, because he is a mechanic!

Surely, then, we must admit that there is no hard and fast boundary between the brain-worker and the muscle-worker. There is no muscle-work without brain-work; there is little brain-work of a high order without muscle-work.

There are, however, gradations. There are kinds of muscle-work, so simple, so monotonous or uniform in their character, that they are, with very little practice, performed automatically, with no conscious effort of the brain. Such, for instance, is the work of the agricultural laborer in digging, mowing, thrashing, etc., or of the hodman carrying bricks and mortar up a ladder. All such work, it is generally found, can be performed by means of machinery. Perhaps this may enable us to find a definition, or rather a limit, for muscle-work.

I must now ask what classes of society can rank as brain-workers. Dr. Beard seems to include here, clergymen, lawyers, physicians, merchants, scientists, and men of letters. He does not make any mention of artists, teachers of different branches of knowledge, manufacturers, etc. Now, if the merchant, the man who distributes, fetches, and carries, is to rank as a brain-worker, surely must the producer, who much more frequently originates out of his own mind something new to the world. We may also ask, Does the term merchant include the retail dealer, the clerk, and the commercial assistant? If so, we find the brain-working class re-enforced by a number of persons who certainly have little need for muscular exertion, but little also for brain-work, and many of whose tasks and duties might be performed by machinery. Again, where are we to place the speculator, the gambler, and the forger? Muscle-workers they are only to a very small extent, though the forger requires a wonderful amount of manipulative skill. He must, however, be regarded as a doomed species, since the Nesbit patent safety-check carries in it the germs of his destruction.

It becomes very difficult to say with accuracy who are to be classed as brain-workers and who as muscle-workers, and, still more, who are to be referred to Dr. Beard's third class, "those who follow occupations that call both muscle and brain into exercise." This class, as I have endeavored to show, includes almost every one who works at all. Until we are able to furnish a correct classification of mankind as brain-workers and muscle-workers, it will be very difficult to enunciate any true and valuable proposition concerning either group.

Twenty years ago, Dr. Beard laid down among others the following set of propositions: That the brain-working classes—clergymen,

lawyers, physicians, merchants, scientists, and men of letters—live very much longer than the muscle-working classes; that the greatest and hardest brain-workers of history have lived longer on the average than brain-workers of ordinary ability and industry; that clergymen are longer-lived than any other great class of brain-workers.

The first of these propositions admits of statistical proof or disproof. The life-lengths of the classes of men above mentioned can be ascertained, and their average duration compared with the mean length of life prevalent in their times and countries. But is the superior longevity of these classes due to the fact that they are brain-workers, or must it not be traced to a complication of causes? If brain-work is *per se* salutary and conducive to long life—which I do not deny—and if, as we may gather from Dr. Beard's second proposition here given, its beneficial influence is proportionate to its intensity, we should find the men whose brain-work is devoted to origination stand highest in the list. As such I should undoubtedly rank discoverers in science, inventors in the industrial arts, poets, musical composers, and painters (not of portraits). But the third proposition entirely clashes with this conclusion. Dr. Beard tells us that, of all brain-workers, clergymen are the most long-lived. Yet they can scarcely be called the hardest brain-workers, since what is demanded from them is not origination, creation, but expression. If a clergyman initiates new doctrines he is in danger of becoming a heretic. He is expressly forbidden to do what is expressly demanded from the man of science or the author. Indeed, till a comparatively recent date, the life of an English country clergyman has always been considered as one of the easiest of all careers, making no heavy demands either upon brain or muscle.

Indeed, Dr. Beard, when he undertakes a formal explanation of the great longevity of the clergy, makes some very important concessions. He remarks that "their calling admits of a wide variety of toil"—"In their manifold duties their whole nature is exercised"—"Public speaking, when not carried to the extreme of exhaustion, is the best form of gymnastics that is known." Dr. Beard here admits, what I also maintain, that the most healthful work is that which duly and harmoniously calls into play all the various faculties of a man. Brain-work is in itself good and wholesome—undoubtedly better than pursuits which exercise the muscles alone, leaving certain regions of the nervous centers inactive. But it is still inferior to work which exercises the entire system. Whatever calling effects this most thoroughly and equally will be the ideal vocation. But it may be said that the duties of the physician call a wide circle of powers into play. Why, then, is he less long-lived than the clergyman? In his case there is wanting any physical exercise which may take the place of public speaking, and he is more exposed to death from contact with malignant disease.

As an instance of the especial benefit to be derived from an exer-

cise of the whole system, I may glance at the lessons to be gathered from the experience of exploring expeditions in unhealthy countries. The first to succumb are porters, guides, muleteers, private soldiers and sailors, etc. Next come military and naval officers, while the doctor, the botanist, the geologist, etc., hold out to the last, their sole advantage being a more thorough exercise of the whole system, muscle and brain alike.

Dr. Beard gives another reason for the longevity of the clergy—their comparative freedom from anxiety. This is the critical point to decide whether brain-work shall be healthful or harmful. Let a man work knowing that his livelihood is secure—that it is indifferent whether he completes any given task this month or this time six months—and no amount of study will harm him. But tell him that he must complete some task by a given date under penalty of dismissal, or that his prospects in life depend on his passing an examination better than a score of competitors, and the probability is that his studies will bring on softening of the brain, heart-diseases, or perhaps Bright's disease.

Dr. Beard formally admits that "worry is the one great shortener of life under civilization, and, of all forms of worry, financial is the most frequent and the most distressing." Hence the differences between his views and mine are very much smoothed over, and we must take in a "Pickwickian sense" his declaration elsewhere that "brain-work is the highest of all antidotes to worry."

He brings forward yet another reason for the longevity of clergymen—"their superior temperance and morality." That such superiority, if it exists, will have an influence in favor of health and long life, I readily admit. But it is very doubtful whether they are in this respect superior to other brain-workers. In the career of the scientist mutinous passions are simply crowded out. For him the struggles with temptation, of which the ethicists tell us, have simply no existence. How it may be among those brain-workers who move in a more emotional sphere, I can not presume to say.

Dr. Beard's contention that the brain-worker is, as a class, happier than the muscle-worker, is very questionable. He asks: "Where is the hod-carrier that finds joy in going up and down a ladder; and, from the foundation of the world until now, how many have been known to persevere in ditch-digging or sewer-laying, or in any mechanical or manual calling whatsoever, after the attainment of independence?" Such persons, I think, might be found. Many of these manual occupations would, as far as I can judge, seem happier than a life spent at the merchant's desk or at the exchange. If the man of business "continues to work in his special calling long after the necessity has ceased," it is because he has been trained to believe that accumulation of wealth is the whole duty of man. "Nearly all the money of the world," says Dr. Beard, "is in the hands of brain-workers." This may be true; yet, at the same time, many of the hardest and most capable brain-

workers rank among the very poorest. Young men are now warned by their friends to avoid the highest class of brain-work, and even to shun the learned professions, "because they do not pay." I meet with books containing the records of original research, yet for which the author has received less than the wages of a stone-breaker for the time employed. I meet with inventions which ruin the inventor and enrich his followers. Verily the manual laborer has scant cause to envy the brain-worker.—*Journal of Science.*

SKETCH OF PROFESSOR RICHARD OWEN, F.R.S.

PROFESSOR OWEN'S especial field of labor, that of comparative anatomy, covers every portion of the realm of zoölogy; and in that field, as one of his biographers well observes, he has published original papers on every branch of the animal kingdom, living and fossil. Another writer, reviewing his work, has said felicitously and justly that, "from the sponge to man, he has thrown light on every subject he has touched."

RICHARD OWEN was born in Lancaster, England, July 20, 1804. He received an elementary education at the grammar-school of his native town, and was for some time a pupil of a surgeon in that place. He became a student of the University of Edinburgh in 1824, and there enjoyed the guidance of the third Monro, Alison, Jameson, and Hope, in the university, and of Barclay in the out-door school. He was one of the founders of the Hunterian Society, and was chosen president of it in 1825. He visited Paris in the same year, and made the acquaintance of Baron Cuvier. Having spent about a year in the study of medicine at Edinburgh, he went to London, and became a student in the medical school of St. Bartholomew's Hospital, where he received the diploma of the Royal College of Surgeons in 1826. He had intended to enter the navy, but had settled down to practice in London, when Dr. Abernethy, with whom he had been associated for a little time at St. Bartholomew's as one of the dissectors, procured for him a position as assistant to Dr. Clift, Curator of the Museum of the Royal College of Surgeons. In this position it was his duty to make the catalogue of the Hunterian collection; and he prepared catalogues of the "Pathological Specimens," "Monsters and Malformations," and, chiefly, of the "Specimens of Natural History in Spirits," in 1830 and 1831. He continued the study of these collections through many years, succeeding Clift as curator of the museum on his death, and was gradually led by them to the extensive field of research with which his name is connected. In order to identify the specimens, it was necessary to make new dissections; and these were constantly opening new paths of inquiry and leading to new discoveries. He

issued a "Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy," in sections, from 1833 to 1840; the "Paleontological Catalogue," in 1845 and 1854; and the "Catalogue of Recent Osteology," in which he described 5,906 specimens, in 1854. The work of cataloguing and examining for the catalogues was accompanied with constant additions to the specimens and consequent growth of the collection till, in 1856, when Owen's connection with the work ceased, they filled ten times the space that had been sufficient for them in 1828.

An important corollary to these labors was the editorial work he performed upon the writings of Hunter, the illustrious founder of the collection. In 1837 he published a new edition of Hunter's "Animal Economy," to which he added all the known published papers of the author; and he gave, in the preface, the first descriptive narrative of Hunter's real discoveries. He afterward published two volumes of Hunter's "Essays and Observations on Natural History, Anatomy, etc.," which had been transcribed by Clift before Home destroyed the originals, and had been deposited by him, with an autographic authentication, in Owen's hands. The preface to this work embodied a showing of the advanced views which Hunter entertained in geology and paleontology.

In 1834 Dr. Owen was appointed to the newly-founded chair of Comparative Anatomy in St. Bartholomew's Hospital, and two years afterward was made the first Hunterian Professor in the Royal College of Surgeons. He filled this position for twenty years, after which, in 1856, he was appointed Superintendent of the Natural History Department of the British Museum.

The history of the whole of the earlier thirty years of Professor Owen's active life is illustrated by the records of his anatomical and zoölogical investigations. His earliest published paper was a demonstration of the manner in which an aneurism had been obliterated by Dr. Stevens, of Santa Cruz, by means of a ligature of the internal iliac artery, which was communicated to the Medical Society of St. Bartholomew's Hospital in 1830. Soon after becoming connected with the Hunterian Museum, he obtained a specimen of the *Nautilus pompilius*, or pearly nautilus, an animal then almost unknown, on which he published a memoir, with drawings by himself, foreshadowing the advanced views on structure and affinities which characterize his scientific system. In 1835 he published the first account of the *Trichina spiralis*, that remarkable nematoid worm of swine and men which has since become famous as a cause of disease.

Professor Owen's earliest communications to the Royal Society were papers on the generation of the ornithorhyncus and the kangaroo. In numerous later memoirs he discussed the structure and affinities of the higher quadrumana, and proposed the use of the brain-structure as an important element of classification. Between 1840 and

1845 appeared his "Odontography," a very important work, founded on microscopic examinations, containing descriptions and drawings of the structure of the teeth of every class of animals. His "Lectures on Comparative Anatomy and Physiology" were published between 1843 and 1846. His great work on the "Archetype and Homologies of the Vertebrate Skeleton" was the fruit of twenty-one years of study of the subject, and presented a revision of Cuvier's conclusions in the direction of recognizing a greater conformity to type than his illustrious predecessor had been willing to admit. In forwarding a copy of this work to Professor Silliman, of Yale College, Professor Owen wrote, in 1846: "You may remember the condition in which this philosophical department of anatomy was left by the great Cuvier and Geoffroy, and the discussions which unhappily tended to sever those estimable men in the latter period of their lives. The result was the formation of two schools, or parties, in the French world of anatomy, and subsequently the facts and arguments bearing upon these transcendental questions have been viewed in Paris through the prism of such party feeling. The chief and most cherished labor and reflections of many past years have been devoted by me to the acquisition of such truth as might lie at the bottom of the well into which this philosophy of anatomy seemed to have sunk after the departure of the great luminaries of the Jardin des Plantes."

In this work, and one on "The Nature of Limbs," that appeared after it, Professor Owen developed the idea of Oken, that the typical form of development in the higher mammals is the vertebra. In another work, "On Parthenogenesis," he introduced a term, which has since come into general use, to describe a most curious and interesting phenomenon in reproduction.

A very important division of Professor Owen's investigations is his work relating to the apteryx, and other fossil gigantic birds of New Zealand, concerning which he presented numerous carefully elaborated papers to the Royal and Zoölogical Societies. The successful restoration of one of these birds, from the few parts first found, was regarded by him as affording a vindication of Cuvier's principle, that the entire animal may be reconstructed from a single bone, or articular facet of a bone. By other applications of this principle to more or less complete fossil remains he was able to restore many remarkable forms of extinct animals from the fossil fragments brought home by Darwin from South America. He carried on valuable studies on the sloths from the same region, among which was the mylodon, and described the gigantic extinct marsupials of Australia. Turning his attention to the fossil beds at home, he published memoirs on the chelonia of the Purbeck limestones and Wealden clays, and the reptiles of the London clay and the cretaceous formations, and a monograph of the British fossil mammalia. Among his later studies in the field of fossil anatomy is his reconstruction of the curious long-tailed bird from Solenhofen, the *Archeopteryx*.

In one of his communications to the Royal Society (April, 1872), on the fossil mammals of Australia, he remarked, touching upon some generalizations suggested by the then present stage of discovery, that "the disappearance of the larger species was explicable on the principle of the 'contest of existence,' as applied by him to the problem of the extinction of the fossil birds of New Zealand ('Transactions of the Zoölogical Society,' vol. iv, 1850), and subsequently by Darwin to the incoming of new species, as 'the battle of life.'" In concluding this paper he remarked that "it is neither creditable nor excusable that so great a divergence should still be maintained, chiefly through theological teaching, in the ideas of the majority of men 'of ordinary culture' as to the cause and conditions of the distribution of living species over the globe from those suggested by the clear and multiplied demonstrations of science." One of his studies in the London clay, in 1873, brought to light the *Odontopteryx*, a fossil bird, having the peculiarity not found in any existing bird, and one previously unknown in birds, of jaws provided with long, conical, bony processes, like the serrations in a coarse saw.

When he assumed the position to which he was called at the British Museum, Professor Owen's attention was at once directed to the insufficiency of the space the museum afforded for the accommodation of the natural history collections. Repeated representations had already been made on this subject in vain. The Government would not enlarge the provisions at the museum, and finally intimated that it would prefer the alternative of having the collections removed. Professor Owen determined to accept this alternative, and had plans prepared for a large new museum at South Kensington, which would afford a superficial space of five acres to well-arranged collections. The plan was approved by the Government, but did not receive the favor of the House of Commons. Professor Owen then published a pamphlet "On the Extent and Aims of a National Museum of Natural History" (1862). After ten years more of agitation, a parliamentary appropriation was obtained, in 1872, with which the present magnificent range of buildings, now rapidly filling with the nation's treasures of natural history, were erected. "In the obtaining of this splendid casket in which to display Nature's gems," says "Nature," "Professor Owen has seen accomplished one great object of his life." "Nearly a quarter of a century," said the same journal in 1880, "has elapsed since he entered on his duty at the British Museum, and the record of his contributions to science during this period equals, if it does not surpass, that of the previous thirty years' period. Among the more important of these we must notice: 'Memoir on the British Fossil Reptiles of the Mesozoic Formations—Pterodactyles,' 1873–1877; 'On the British Fossil Reptiles of the Liassic Formations—Ichthyosaurs and Plesiosaurs,' 1865–1870; 'On the British Fossil Cetacea of the Red Crag,' 1870; 'On the Fossil Reptiles of South Africa,' 1876; 'On the Classification and

Geographical Distribution of Mammals,' 1859; a 'Manual of Paleontology.' The long list of papers published in the 'proceedings' of learned societies, to be found in the Royal Society's invaluable catalogue (numbering over three hundred and sixty), includes many the scientific value of most of which would have given an abiding fame to their author."

Professor Owen was a member of the commission to inquire into the health of towns, in 1843 and 1846; was one of the commissioners on the health of the metropolis, in 1846 and 1848; and was a member of the commission on the meat-supply in 1849. In 1848 he published a special report on the sanitary condition of his native town of Lancaster, which was followed by the introduction of an improved sewerage and a new water-supply. He was one of the commissioners for the Great Exhibition of 1851, and was chairman of two of the juries in the Great Exhibition of Paris in 1855.

In the way of honors, Professor Owen received the Royal Medal from the Royal Society in 1842, and the Copley Medal in 1846; the "Ordre pour le Mérite," from the King of Portugal, in 1851, and the Cross of the Legion of Honor from Napoleon III in 1855; degrees from the Universities of Oxford, Cambridge, and Dublin; and an honorary Fellowship in the Royal College of Surgeons of Ireland. In 1858 he was elected one of the eight foreign associates of the Institute of France, in place of the botanist, Robert Brown. Prussia gave him its order of merit, and Italy its order of St. Maurice and St. Lazare; the Emperor of Brazil, the Imperial Order of the Rose; the Queen of England, the order of the Bath. He was President of the British Association in 1857, and his name is on the lists of honorary or corresponding members of most of the learned societies of Europe and America. In 1874 he gave new evidence of the extent and comprehensiveness of his researches by presenting to the Anthropological Institute an interesting paper on the races of ancient Egypt, as depicted in the sculptures. Continuing his studies in this direction, as well as in the whole field of anthropology, he made before the International Congress of Orientalists in the same year, as president of its ethnological section, the most remarkable address of the meeting, in which he recommended adherence to the scientific method in the study of ethnology, and particularly of ancient Egyptian and Oriental history.

In 1880 "Nature" reported Professor Owen as still active in labor at an age when most men have to cease from their work; and added that no better proof could be given of a spirit still young, than to witness the energy with which he had entered upon the occupation of the new home for natural history at South Kensington. Still, in the present year, by the latest accounts received from him, though he is seventy-nine years old, he was in good health, and publishing important papers.

CORRESPONDENCE.

FLORIDA AS A HEALTH RESORT FOR CONSUMPTIVES.

Messrs. Editors.

IN "The Popular Science Monthly" for March, Dr. George E. Walton, of Cincinnati, has an article on "The Remedial Value of the Climate of Florida," some of the statements in which, for the sake of accuracy, it seems desirable to correct.

What Dr. Walton says of the humidity is true. It can not be compared with Minnesota (that is, the northern part of Minnesota) for dryness; but it will compare favorably with other *southern* localities in Europe and America; for instance, we see by Dr. Walton's table, page 644, that the humidity of San Antonio and Florida is about the same; and just here let me say that writers on Florida climate are apt to take Jacksonville as a *representative* locality, because the available statistics usually come from there. The Signal-Office is there. But it is by no means the best locality for invalids. It has the advantages and the disadvantages of a city, though a small one. It is much damper than other points in East Florida frequented by invalids; fogs are more prevalent, and last longer. It is not so safe to be out after sundown. As we go up the river the dampness lessens for a hundred miles. During the months of February, March, and April, 1878, using a Mason's psychrometer (wet and dry bulb), and comparing my observations with those of the Signal-Office at Jacksonville, the relative humidity for three months, in 1878, is for that city 66·2, according to Dr. Baldwin's observations for several years 62·6, *while for Palatka it is* 61·3.

The summer dampness is just what Dr. Walton says of it, three fourths of all the rain-fall of the year occurring during that season. But, further on, Dr. Walton says, "The prime need of a consumptive is that he shall be a great deal out-of-doors, that he shall breathe pure air," etc. "Is the climate of Florida fitted to do this? . . . I answer no!" On the contrary, I answer emphatically yes! Here is just the advantage of Florida over the cold and cool resorts. Here, one is constantly incited by the sunshine and the delightful climate to be all the time out-of-doors. As regards physical exercise, during most of the time one is not incited to *it*. But there are *cool changes* during the winter and spring months (which are peculiar to this climate, distinguishing it from a purely tropical), during which one may exercise on horseback, on foot, or by rowing. That people here are indisposed to exercise is true; but it is not always, by any means, because of the temperature, but of constitutional indolence Those who take an interest in their surroundings, or who are fond of fishing and hunting, may be seen at all times, in warm and cold weather, putting forth all requisite energy. Persons must *seek occupation* and *amusements* in order to get the benefit of climate. What Dr. Walton says about *tubercular* consumption, especially the latter stage, is true, and it is true of cool and cold climates also, but not to the same extent, perhaps, as of warm and moist. That is, the universal admission of all honest writers on climates and health resorts is, that such cases die wherever they go. They are necessarily incurable, with very few exceptions, and notable exceptions occur here as elsewhere. And here let me explain why so many more consumptive cases die in Florida than in other resorts. When they get reduced almost to death's door by softening of deposits, fever, diarrhœa, etc., they are too ill to go to Europe, and also unable to bear any change, except to a *warm* climate; consequently, the mass of them come to Florida, often with a knowledge on the part of the physician and friends that they are certain to die, but clinging to the last straw themselves.

Dr. Walton says. "During the last six months of 1881 there were thirteen deaths in Jacksonville (population, 8,000) from consumption, these deaths being of residents only, and excluding all non-residents or visiting invalids. This is a mortality of 1·62 per 1,000, being a greater mortality than occurred in Cincinnati during the same time, which was 424 in a population of 280,000, or 1·51 per 1,000. . . . It may be stated in this connection that natives of Florida taken with consumption frequently seek other places and climates as a means of cure."

I am certain that Dr. Walton has fallen into an error in his statement with reference to the deaths from phthisis among *residents*, if he means natives or even persons who have lived many years in Florida. The population of the State is made up very largely of Northerners who have lived here one, two, five, ten years. No doubt many of the deaths referred to by him occurred among this class, probably all of them; for consumption is rare among natives, although they live in every way, for the most part, in opposition to the rules of health—poor food, poor water, poor habitations, insufficient clothes in cold weather—that is, the middle and lower classes do—all tending to the development of tubercular disease, and which

would inevitably produce it in a less favorable climate.

Dr. Walton also refers to the want of statistics from here with regard to the results of the treatment in individual cases. The habit, almost universal, of cases of phthisis moving from place to place in Florida, after a few days' or a week or two's residence, renders the collection of such statistics impossible. And this is one of the reasons why the cases do not get the full benefit of this admirable climate. Even when they are improving rapidly in one location, they get tired and start off to some other, or because some one member of the party fancies a change, or because they have a friend or pleasant acquaintance somewhere else, although a physician may assure them that the change will be for the worse. Even patients who are referred to me by prominent physicians, and told to get my advice as to treatment and locality, go off to some entirely unsuitable place, contrary to my advice, and on that of some casual acquaintance. So much has this come to be the rule, that I now cease to waste my breath in trying to talk them out of their notions.

Respectfully, yours,

FREDERICK D. LENTE, M. D.

PALATKA, FLORIDA, *March* 10, 1883.

AN INTERCEPTED LETTER.

To the Editors of the Popular Science Monthly:

The subjoined letter accidentally fell into my hands, and, as it bears upon a certain much-discussed topic, I venture to send it to you for publication. O. B. B.

NEW YORK, *April* 1, 1883.

DEAR MA: When Suse and me got to the city we found Cousin Ralph at the depot to meet us, and we went right home with him. We had a real nice supper, and as nobody was by but Cousin Lucy, I just told Cousin Ralph plain that Suse and me had come to New York to get what some folks call a higher education. Cousin Ralph, who is real pert, said that some folks he knew, would like to *hire* an education, but I told him that if we could hire an education all right, but we wanted a first class education anyhow, right off, and that Pa was already to pay for it. I said that we had gone through our semnary at home and learned all that old Mrs. Bookup could teach us, and that was why we come to York. Well, Cousin Ralph laughed a little, and then he looked serious, and told us things that made our hair stand on end. Why it taint no use trying to get a first class education here in York because the mean nasty men folk wont let us women get it. What do you think-Cousin Ralph says that they have six policeman before the big liberay they call the Astur liberay to keep women from getting at the books there. He says the street is just full of women a wanting to get into that liberay, but these police officers with their clubs wont let em. There are lots and lots of books in that liberay, Cousin Ralph says, big histories, and big ologies, and big dictionaries, and big books upon ever so many things, and women might get ever so much education by just sitting down and studying them books, but the men are afraid of educated women, so they just put policemen there to drive off everybody that is a female. I declare its a burning shame. Why, Ma, Suse and me might learn all about Bible times, and about astronomy, and geology, and geography, and about Julius Cesar, and Cristofer Columbus, and I don't know what else, and get a higher education all by ourselves if it werent that the men wont let us. I know it will make you real mad when you read this, just as it does Suse and me.

But that isnt all Ma. Would you believe that they won't let women buy books at the bookstores, because if they did they might get a higher education unbeknown. Cousin Ralph says that women cant get nothing but novels to read. The bookstores are just full of books that teach everything you can think of, and yet even when women have got the money to buy them the men wont let them do so. Cousin Ralph says there are books full of learning by somebody called Spensur, and some one called Hucklee, and another man called Tindell, but that it is as much as a woman's life is worth to go in and buy one. Cousin Ralph thinks she couldnt get out alive, at least he says he never saw a live woman come out of a book store with one of them books. All women would have to do to get a real first class education would be to go and get books out of the book stores, but the mean jealous men say they shant do it, and so keep them just as ignorant as they can be. And then Cousin Ralph says they wont let women go to lectures on history, and the siences as folks say. There are lectures given free at what I think Cousin Ralph called the Hooper Union, but he says if women went there to get lectures free, theyd be just driven off by policemen. Lots of things might be learned by going to lectures, but the poor women arent allowed to. Its real dreadful what a time we women have in trying to get learning.

And then Cousin Ralph says that the publishers wont publish books anymore with learning in them. Why they just print lots and lots of trashy novels which women have got to buy because they wont print nothing else. There's what is called the Franklin square liberay and the Sea side liberay, that keep on printing good for

nothing novels, and women who want cheap books have to read them, because the men who print books dont want women to get a higher education, they really dont, and so they just flood the country with books that women have to read, because they cant get into the public liberaries, and aint allowed to buy books by Spensur and other learned people. Its just a conspiracy, Cousin Ralph says, to keep women down. I think its a great shame, dont you, Ma. But Suse and me mean to see if we cant get a first class education somehow. More next time, from

Your affectionate daghter,
MOLLY.

EDITOR'S TABLE.

GREEK AND LATIN AGAINST NATURE AND SCIENCE.

NOTWITHSTANDING all the efforts to reconcile and bring into harmony these great elements of education, it must be admitted that the antagonism stands out to-day more decisive than ever before. All the tendencies concur to sharpen and intensify it. In the light of the Baconian conception that "man is the interpreter of Nature, and Science its right interpretation," natural knowledge is rapidly extending and vindicating its increasing claims upon the mental cultivation of the age. But the capacities of acquisition on the part of youth remain limited; life is short, the period of study shorter, and the competition of subjects has forced more urgently than ever the necessity of choosing what shall be adopted as means of education and what passed by. Meantime the traditional culture fights every inch of the ground, will concede nothing, and redoubles its efforts for extension at every opportunity. The colleges raise their standards of the amount of Latin and Greek required for admission, and thus react upon the preparatory schools to stimulate classical studies and give them a higher place in popular consideration. There is, besides, a vigorous and wide-spread movement in behalf of what is called the "higher education of woman," which simply means the traditional ideal of culture. The female colleges are proud to duplicate the curriculums of the old classical establishments, and boast that they do not lower the standard of Latin and Greek. The boys have had a Latin school in Boston for two hundred and fifty years, to prepare for college; and the girls of that city, after failing to get into the old one, have established another within the past five years, which is said to be most flourishing and successful: rivalry and conflict are therefore inevitable, and our age has before it the broad issue between Latin and Greek on the one hand, and Nature and Science on the other hand, as means of cultivating the youthful mind.

The classical education is old, established, and invested with historic dignity, and as a consequence it is imperious and arrogant. That it has gone on for many centuries, is offered as its best reason why it should always go on. That there has been a progress in knowledge and in the human mind which has brought about a new order of things is ignored by it as of no significance. Nature and Science are regarded by it as mere upstarts of yesterday, full of vain pretension, and deserving only to be snubbed and thrust contemptuously aside. The last expression which we have seen of studied disparagement of Nature and Science in connection with education is an article by Mr. E. R. Sill, that appeared in the "Atlantic Monthly" for February, on "Herbert Spencer's Theory of Education." Mr. Spencer's little book upon that subject, as is well known, is a plea for more of nature and of science in our methods of mental cultivation, and Mr. Sill's article is a protest against this whole doctrine. He comes forward as a partisan of the old

classical education, as opposed to the modern study of nature by the method of science. Exactly what he means by "Nature" does not so plainly appear, but by his instincts as a classicist, alive to the present emergencies, he is "down upon it" whatever it be—witness the following passage:

> For what is this "Nature" (with a capital N) which figures so largely as a final arbiter in the enthusiastic eulogies of Science (with a capital S)? Does this Nature include man and his operations, or does it not? If it does, then these very interferences are also a part of Nature. And certainly the human part of Nature has as good a claim to be the arbiter as any other part. But if it does not include man, and is merely a name for the forces and processes of the world outside of the human world, then we may safely assert our right to come down upon this Nature, and mold and control it according to our needs. Or if, to take a third supposition, this capital-lettered Nature is meant to include man only in his "natural" condition—the wild man so called, the savage, the animal—then surely the very effort of all civilization, and of education as its chief instrument, is to oppose, and whip in, and convert, and take command of these untamed forces of Nature, that we may develop the savage into the higher human being.

Now, the nature about which Mr. Sill is here so dubious, and of which he seems to be so jealous, is by no means a difficult thing to define and understand. For the purpose here in view it is the order of things in which man is placed, of which he is a part, and of which it is his highest intellectual prerogative to be the interpreter. And it is to be remembered that "this Nature" is something which had no existence in that golden age of classical antiquity which gave origin to those literatures still claimed to be best for the cultivation of the human mind.

It is sufficiently obvious that relatively to man what nature is depends upon what *he* is. To him who is ignorant of it, nature is one thing; to him who understands it, nature is another and a very different thing. How the savage regards the world, we need not here inquire, but it is desirable to know how it was possible to regard it after human culture had become greatly advanced.

Man did not begin his mental career by the study of nature. The earlier forms of mental cultivation were literary. The Greeks and Romans developed poets, dramatists, orators, historians, critics, and artists of fine accomplishments while yet nothing was known of nature. The external aspects of things were described with great fidelity, but the view was sentimental, poetic, and superficial. Into the secrets of nature at that time men could not penetrate, its course they could not explain, its order they could not conceive. They had no clew to the interpretation of even its simplest phenomena. They could look, but they could not observe; they could construct, but they could not experiment; they could guess, but they could not verify; they could speculate, but they could not create positive knowledge. There is much of interest, art, and beauty in the literatures of Greece and Rome that has been a source of pleasure to all succeeding times; but these proficiencies brought no capacity to explore and understand the surrounding world. In all the thinking, therefore, of the classical ages, nature was simply left out.

But this was not always to continue. The earlier and lower forms of mental effort gave a preparation for profounder work. Yet it was only in modern times that men began to learn how properly to inquire, and to prize the truth that results from inquiry. After much vagrant exertion, and a long and painful apprenticeship in the processes of investigation, science began to take definite form as a higher manifestation of intellectual power. Humanity had grown to a new function. The art of questioning Nature through observation and experiment was slowly perfected; the facts arrived at were classified and inductive truths established, and there

grew up a new order of knowledge, which, at the same time that it gave insight into the constitution of natural things, conferred also vast power for the purposes of human improvement. We are justified in saying that in a high sense a new universe was thus created for the human mind. Through scientific knowledge man entered upon a higher intellectual career and first gained a real conception of his own possibilities and true position in the world. A new civilization followed, which is signalized in a thousand ways; and the answer to Mr. Sill's question, "What is this Nature (which figures so largely as a final arbiter in the enthusiastic eulogies of Science)?" is given in the powerful mental movements of all enlightened nations for the cultivation and extension of that natural knowledge which has become the controlling agency in the improvement of human society.

And is it to be supposed that this new power in the intellectual world is to remain impotent in the domain of modern education? Can the great revolution of ideas in regard to nature fail to bring about a corresponding revolution in the mental cultivation of mankind? The simple question is, whether the minds of our youths are to be developed in future by means of the lower or by means of the highest and most perfect forms of knowledge. Those who offer the classics as an all-sufficient means of culture discredit the achievements of modern thought, and have no more use for the knowledge of nature than had the ancient classical authors before such knowledge existed.

Mr. Sill puts his educational theory in the following nutshell, which, as will be seen, finds no room for nature. He says: "The truth is, there is a permanent aspiration in man for spiritual enlargement, for higher and richer planes of intellectual being. This aspiration has in every age reached out, no doubt more or less blindly, after whatever was greatest and best in preceding human attainment. Latin and Greek have been studied, not alone, as our author almost seems to suppose, as words and for words' sake, but for the vital contact they give with the living men who thought in Latin and Greek."

Now, granting this permanent hunger for spiritual enlargement, the question still remains how that hunger is to best appeased. Mr. Sill says by "the accumulation of man's thought and feeling concerning human life and affairs." But *what* "accumulation"? Why, the literary treasures of Greek and Latin, of course. The yearnings of human nature after intellectual illumination are to be met, not from the magnificent treasures of truth which are now the grandest possession of humanity, but by the undeveloped thought of two thousand years ago, and by bringing the minds of our youth "into vital contact with the living men who thought in Latin and Greek." The absurdity is self-evident. Men's aspirations are not to be thus satisfied. The thought concerning human life and affairs which we require for mental cultivation is modern thought—the knowledge which bears upon the emergencies to be encountered. Only by the light of the most advanced science can affairs in these times be intelligently dealt with. Our age is full of living questions which can only be resolved by modern methods. To go back thousands of years after the intellectual help we need is simply to shirk the responsibilities of the present age.

Knowledge of nature for guidance in life is the great requirement. But Mr. Sill does not seem to recognize that knowledge has any function of guidance. There is disparagement throughout his paper of the importance of knowledge for any use that can be made of it in the conduct of life. Mr. Spencer had classified the knowledges in his little book as they bear upon the activities of life, and had ranked first "those

activities which directly minister to self-preservation"; and, next, "those activities which secure the necessaries of life, and so indirectly minister to self-preservation"; and then "those which have for their end the rearing and discipline of offspring." The social and political relations come next in importance; and, finally, those matters of literature and art which belong to the leisure part of life. Mr. Sill says that this scheme is fundamentally erroneous, and, in fact, "the exact reverse of the truth." Bodily and material interests are studiously belittled. Mr. Sill says: "The ordinary man, unenlightened by education, manages pretty well this matter of getting a living for his body; which is, no doubt, a necessary condition to any intellectual life, but is intrinsically of considerably less importance than that higher end, which alone, indeed, gives it any value whatever." Again, "As to the body, and as to the getting a living for it, and even as to the care of offspring, something may be left to nature and to natural instinct"; and yet again, when a youth has first become "an intelligent man," according to the traditional ideal, "he will be able to get his handy information for himself afterward, as happens to be most useful to him."

This undisguised contempt of a knowledge of the human constitution and the conditions of its welfare is more than classical. The ancients were ignorant of these things, and therefore indifferent to them; it is only in the degraded scholastic ages that we find the body and bodily interests systematically undervalued and despised. But better reasons could be given in those days for hating and crucifying the corporeal nature than can now be given for neglecting to study and understand it. Mr. Sill reasons that it is only the "higher end" which it subserves which gives man's bodily organism any value whatever; and this higher end is "spiritual enlargement," and, as spiritual enlargement is to come by vital contact "with the living men who thought in Latin and Greek," we arrive at the luminous conclusion that the final purpose of the human constitution is to acquire a knowledge of the dead languages. If this is the upshot of our existence, Mallock's question, "Is life worth living?" is not, after all, so futile. But, if we grant that it is worth living, that knowledge is of first importance which qualifies us to preserve it. To disparage this knowledge, to discourage it, or to crowd it out by any other knowledge whatever, on any pretext, is nothing less than a crime. That life is imperiled on all sides, by agencies working so variously and so fatally, and to the ignorant so mysteriously, that Divine Providence is constantly accused of arbitrary interference to destroy it, is undeniable. Science alone has furnished that knowledge of the human organism and of surrounding nature that confers the power of warding off the causes of death, and thus leads to a more reverent view of the government of the world. Right and left, and every day, and all around us, men, women, and children are struck down and sent to unripe graves for lack of the knowledge which science has given of the avoidable causes of death. And the same thing may be said of a great number of the diseases by which, if life is not ended, it is turned into a calamity and a curse. Again, science informs us concerning the operation of those numerous causes by which vitality is depressed, the bodily and mental constitution enfeebled and undermined, and existence made worthless for all its better purposes. And, yet again, we owe to science the knowledge of those laws and conditions of the human organism by which it may be improved, increased in its capacities of enjoyment, and augmented in its powers of effective action.

Classical education is worthless for all these objects. It leaves its victims in a state of ignorance as baleful as that

of the helpless illiterates who have never crossed the threshold of a schoolhouse. We pick up an admirable pamphlet by an experienced teacher of this city, Mr. John McMullen, on "The Education of the Rich." Now, the education of the rich is generally fashionable, traditional, and classical, but for the vital purposes of well-being it gives them but little advantage over the wholly untaught. Mr. McMullen pleads that the rich need to study vulgar and common things as well as the industrial classes. His words are well calculated to enforce the view taken in this article. He says:

"Is it not time that some humane person should make a movement in favor of the industrial education of the rich? Since they must live in houses, why should they not be taught something about them? Defective masonry means cracked walls and obstructed doors; defective carpentry means general discomfort and an occasional crash; defective flues mean midnight fires; while defective plumbing and ventilation mean diphtheria and death.

"Let us at least teach them enough to prevent them from being poisoned by the plumber, dying 'as the fool dieth,' like rats in a corner, in the luxurious homes which they themselves, perhaps, have reared. Thus we have read recently in the papers, of one man who built an expensive and luxurious house, and lost four children in one month from diphtheria. Some three years ago, I had in my school two bright boys, the sons of intelligent and educated parents. A little brother at home sickened and died; then a little sister; and then one of my scholars became sick. A thorough examination of the house was made, and a faint, musty smell was traced to the bath-room. The mother found, to her horror, that these deaths were due to defective plumbing, and that they might have been prevented. She fled in terror from the city, and has never since returned."

DR. DIX ON THE WOMAN QUESTION.

From the amount of screaming and denunciation in the newspapers, both by editors and by correspondents, regarding Dr. Dix's lectures on woman, we infer that somebody has been badly hit, and that the doctor is to be paid off in abuse. A lady, for example, writes to the "World": "I have observed that Dr. Dix has made haste to publish his Lenten lectures without waiting for the close of Lent. This alertness is creditable to the practical and mercantile instincts of Dr. Dix. His lectures will sell now if they are ever to sell." Probably in anticipation of such insinuations, the author has prefixed a note to his volume from which we quote a few words: "I ask the reader of the following lectures to bear in mind—1. That they were written for my own people, and in the line of my usual pastoral work. 2. That they were not intended for publication. 3. That I now give them to the public in my own defense, because of the misrepresentation of my views by critics who had not the means of knowing exactly what I said, or all that I said. They are printed just as they were delivered, with scarcely the change of a word; and, in order to comply with the request of the publishers that they should appear at the earliest possible day, I am obliged to omit adding a large number of notes and quotations by which, if more time were allowed me, I should have endeavored to fortify by strong authorities the position which I have taken." Whether it was wise in Dr. Dix to yield to the hurry of his publishers, and send out his volume unfortified by the evidence at his command, may be a question; but that it was done in compliance with their wishes shows that his own preference was otherwise, and sufficiently relieves him from the mercenary imputation of the "World's" correspondent.

Dr. Dix is entitled to have his read-

ers remember that the lectures were prepared exclusively for pastoral use, and not intended for publication, and that they have had to be printed in self-defense against misrepresentation; and this consideration should be borne in mind in their public criticism. It by no means follows that he keeps a private set of opinions for special pastoral application, and for which he is unwilling to be held publicly responsible. He was addressing a class of Christian believers who profess allegiance to Christian doctrine, as expounded by his Church; and he very naturally gave prominence to considerations which would have but comparatively little force with outside multitudes who are not in sympathy with his ecclesiastical views. As to the theological arguments which Dr. Dix brings to bear upon the woman question, we have no interest in them except so far as they strike downward and find their basis in the truth of nature. But with the main fundamental doctrines he lays down as of all-determining influence, we are in cordial agreement.

The last phase of attack upon him is an accusation that his views are not new. The "Pall Mall Gazette" declares that many of the faults of women which he notices are not American but universal, and have been recognized and satirized in all ages; and an American commentator observes that "his views of the character and duties of woman do not differ greatly from those set out in the laws of Manu, which, according to the Hindoo theologians, were drafted thirty millions of years ago."

But when the New York "Evening Post" proceeds to affirm of the cardinal doctrines of Dr. Dix that "they are in fact the views by which every step in the elevation of woman, from the beast of burden of the savage to the mistress of the modern drawing-room, has been contested by conservative or timid males, lay and clerical," it becomes worth while to revert to the author's own statement of them. The following passages from the first Lenten lecture may be fairly taken as the key to the whole exposition:

> The place and work of woman in this world are, then, a place and a work in social life. And her place and work are not those of the man. His work lies outside, hers within. Without her, society could not have existed; without her, it can not last. The fact that in forming society man and woman have distinct parts implies this, that in maintaining and developing their work they shall continue to act in distinct relations to it. Something there shall be which man only can do; something which woman only can do. If she leave her own work and try to take up his, her work will remain undone; for man is not fool enough to try to do hers. And her work is inner rather than outer; it runs in the line of ordering, comforting, and beautifying. Her place is in the home first, and then in general society; and these depend on her for a grace, a help, a harmony, a good ordering, which no one else can give.
>
> These considerations give the turn to every thought of ours about woman's work. It is impossible for me to think of it at all, without first thinking of her place in the home. That is her normal, primal seat; thence are derived all true conceptions of her rights, duty, and mission. I know the objections which will arise in your minds: that there are many women without homes or the means to make them; and, again, that, as if by a bitter sarcasm of fate, the world of to-day is so changed that it often seems as if woman must work the harder of the two in order to support the shiftless man. There are answers to these and similar objections: I shall try to give them by-and-by. But for the present I must leave the subject at this point, adding but one suggestion. I do this earnestly, seriously, and as one would speak of a matter of life or death. Let me then say that, whatever it be in thought, deed, or will that works among us now to break up the home, to make the home-idea mean and contemptible in the eyes of woman, or to unfit her for domestic duties and disgust her with her proper work, whatever now acts on her high-wrought nature, her ambition, her self-love, to turn her steps away from the home-life, and inflate her with visions of a career in the public places outside—this, whatever it be, is working against the best interests, the hope, the happiness of the human race.

If, through ease, self-indulgence, and luxury, through curiosity of learning, through self-esteem and ambitious rivalry of man, a woman becomes disloyal to the home-idea, and despises it in her heart, she is, though perhaps unaware of the fact, helping others to upset the social order.

These weighty words express the central, illuminating, and all-controlling conception of the Lenten lectures. It may be that Dr. Dix could not get a patent on these ideas for their novelty, but are they the views which, as the "Post" alleges, have been employed to resist the elevation of woman in all times? And what is there in them, expressed or implied, that can be construed as unfavorable to female elevation? Dr. Dix is no opponent of the improvement of woman by education; he only lays down the conditions on which all education which can really elevate her must depend. His views may not be new, but they have an urgent application to the tendencies of the present time. The prime postulates of all his reasoning are that woman is a different being from man, and has a different sphere from man, and, if she is to be educated in accordance with the requirements of her nature and position, she must have a different culture from that of man. His telling strictures are accordingly leveled against the wide-spread demand of the present time, that woman shall gain access to the men's colleges that they may obtain the "higher education" of men, and thus adapt themselves to the sphere and pursuits of men. Dr. Dix maintains that this would inevitably be subversive of the home-feeling; and he charges that the aspirants for wider careers have become restive under the restraints and obligations of their sex, and are cherishing ambitions which lead to a general neglect of home-life, and that will only confirm and strengthen the sentiment of disloyalty to the home. The "Evening Post" characterizes these views as a "bold defiance of the soundest, most enlightened, most religious, most conscientious judgment of the day in all lands, on the condition and needs of female education."

But is Dr. Dix really so far wrong as this extravagant language implies? We have not so read the signs of the times. If there is one thing that pervades and characterizes what is called the "woman's movement," it is the spirit of revolt against the home, and the determination to escape from it into the outer spheres of activity that will bring her into direct and open competition with men. In all the talk about female "higher education," and in all the new plans for its extension, it is notorious that distinctive home interests find no place. The literature of the woman's movement is saturated with denunciations of the vulgarity, drudgery, and slavery of life in the domestic sphere; and the "higher education" proposed is not an attempt to ameliorate, redeem, and exalt it, but a rebellion against it. The education that prepares for the home, that would awaken interest in it, give dignity to it, and transform it, is simply scouted. That the feminine nature is different from the masculine nature—different throughout, physically, intellectually, emotionally; that woman's claims, her duties, and her destiny, are profoundly different from those of men, and that her culture should have relation to the requirements of her nature—is derided by all the leaders of the present crusade to get women into the men's colleges.

The fundamental law of educational progress is differentiation of the mental activities, division of labor. In accordance with this law, we have classical colleges, medical colleges, law colleges, engineering colleges, agricultural colleges, dental colleges, and veterinary colleges, all different in the knowledge they impart and the preparation they give for the work of active life. And we have also female colleges—

Vassar, Cornell, Smith, Wellesley—all distinguished by a violation of this fundamental law of progressive education. They are all imitations of the old classical establishments, and their pride is in the perfection of the imitation. It is their boast, if not, indeed, the first condition of their endowment, that the feminine nature has no recognition either in their objects or grades of study.

If there is one female college in the land which is devoted to the cultivation of woman as an intelligent being for the discharge of her responsibilities in domestic life—which qualifies her for it, as the medical college qualifies the physician for his practice—we have not heard of its existence. It is a consequence of the rapid diffusion of education that the traditional methods of instruction are enormously extended, while existing institutions and current educational literature combine to give omnipresent influence and irresistible strength to distinctively masculine thought—that is, thought mainly pertaining to masculine spheres of action. The whole force of these ideas is brought to bear to kindle in woman ambitions of study in all these directions. Thus influenced, she wants to go into politics, law, medicine, art, literature, philanthropy, religion; and, thus influenced, she is drawn away from the home sphere, despises it for its vulgarity, and hates it as a clog and drag upon all her noblest aspirations.

Let it be emphasized, then, that those who oppose the entrance of women into the colleges that have grown up to meet the distinctive requirements of men are not, therefore, opposed to the better or higher education of woman. But that only is "higher education" for woman which perfects her nature, capacities, and requirements. Dr. Dix's view of the import of the home in civilization, its vital and ruling place in the social order, we believe to be profoundly true, and that it must be taken as the starting-point of all substantial improvement and higher cultivation of the female sex. Let women have their own colleges, that shall be neither copies nor appendages of men's colleges, and that shall confer a culture comprehensive, refined, and practical, but with supreme reference to a higher preparation for administering home affairs intelligently, and thus in the most efficient way elevating the standard of social life. When they ask for this education, there will be no opposition, and there will be plenty of means to secure it.

It was inadvertently stated, in noticing "The Gospel of the Stars" last month, that its author, Rev. Joseph A. Seiss, was a clergyman of the Episcopal Church. This turns out to be a mistake, and is resented as an imputation upon that highly respectable body, if we may judge by the number of letters we have received, denying the statement, with varying comments, and declaring that Dr. Seiss belongs to the Lutheran communion, which must be held responsible for him.

In the article "Speculations on the Nature of Matter" ("Popular Science Monthly" for April), the following corrections should be made: On page 798, eighth line from the top, it should read, "namely, the inverse squares of the distance *without* the sphere, and directly as the distance *within* it." And, on line 27th of the same page, it should read "directly as the distance."

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES. No. XLIV.

Animal Intelligence. By George J. Romanes, LL. D., F. R. S. New York: D. Appleton & Co. Pp. 520. Price, $1.75.

The author of this work has come prominently forward within the last few years as an able cultivator of the science of comparative psychology, and the treatise he has now

given to the world is probably the most trustworthy and instructive that has yet been contributed to that science. There has been a copious literature of anecdote designed to illustrate the mental capacities of the most intelligent members of the animal series—as the dog, the elephant, the monkey, and the ant; but while, on the one hand, the statements have often been so extravagant as to awaken incredulity, on the other there has been but little exposition of principles which would enable the reader to judge of the truth or error of current representations. The interest in the subject has always been great, and, with the prevailing lax habits of criticising evidence, many stories have passed into circulation, and been accepted, which would hardly bear examination. It was eminently desirable, therefore, and for scientific purposes imperative, that the popular statements should be rigorously sifted, in order that we may find out what may be relied upon as true. It is obvious that only the thoroughly prepared psychologist is competent for such work, and many years of study in this field have well qualified Mr. Romanes to undertake it.

The present volume is in a certain sense complete in itself; and from another point of view it is but a foundation, which is yet to have its superstructure. It has long been the author's intention to write a treatise upon comparative psychology, in the light of the doctrine of evolution, and his intention was to treat the whole subject in a single work. His preliminary inquiry was, of course, into the facts upon which such a view must rest, but he found his materials so extensive, and in themselves so important, that he was compelled to arrange for two separate books; the first to be made up of the observed facts, carefully collated and classified, so as to give the grades of intelligence actually reached in the various groups of the animal kingdom, and to leave for a second volume the problem of psychical development to be derived from these data. The present book on "Animal Intelligence" is the first, and is mainly descriptive, while the second, to be built upon it, will be more analytic and philosophic.

Undoubtedly the present volume will have the highest interest for general readers, as it involves no speculation or abstruse reasoning, and aims only at descriptions and discriminating estimates of the degree of intelligence manifested in the different groups of animate creatures.

But while Mr. Romanes has closely sifted his materials, so as to furnish only authenticated facts, it would be a great mistake to suppose that his pages are less entertaining than the loose compilations with which we have been familiar upon this subject. The phenomena are equally surprising and wonderful, but with the further advantage that we have a fair confidence in their reality. The intelligence displayed by the inferior animals is often well calculated to awaken astonishment, and we are free to confess that some of Mr. Romanes's stories would excite incredulity if we had not a pretty strong confidence in his caution, and if the special manifestations alleged were not confirmed by other and similar observations. To the general reader, the book will prove a fund of interest on one of the most fascinating of subjects, and to the student of natural history it will have a scientific value as affording a sound basis for the formation of conclusions respecting the psychical capacities of animals.

In regard to the vexed question of mind and instinct in the lower animals, of which so much has been written, the author lays down at the outset the principle that he will follow in determining mental gradation, and this may be gathered from the following remarks in his introduction:

"The criterion of mind, therefore, which I propose, and to which I shall adhere throughout the present volume, is as follows: Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience? . . . I may, however, here explain that in my use of this criterion I shall always regard it as fixing only the upper limit of non-mental action; I shall never regard it as fixing the lower limit of mental action. . . . In other words, because a lowly-organized animal does *not* learn by its own individual experience, we may not therefore conclude that, in performing its natural or ancestral adaptations to appropriate stimuli, consciousness, or the mind-element, is wholly absent; we can only say that this element, if present, reveals no

evidence of the fact. But, on the other hand, if a lowly-organized animal *does* learn by its own individual experience, we are in possession of the best available evidence of conscious memory leading to intentional adaptation."

ESSAYS IN JURISPRUDENCE AND ETHICS. By FREDERIC POLLOCK, M. A., LL. D. Macmillan & Co. Pp. 377. Price, $3.

ALTHOUGH but little oneness of form will be expected in a work like this, composed of occasional pieces which have appeared in divers journals and reviews, yet so much unity of purpose and thought are to be found in it as to give a considerable measure of coherence. The essays fall into two divisions, in the first of which legal topics predominate, in the second ethical. In the first, it has been the author's aim to consider legal ideas and institutions as affected by or as affecting the wider interests of history, politics, and practical legislation. In the second division he has endeavored to bring to a better-defined issue certain points of ethical discussion, by the help of distinctions founded on familiar legal conceptions, and by specifically applying those conceptions and distinctions to admitted facts. In both subjects he has preferred to use the historical method—taking the term in a pretty wide sense. Yet, in respect to the method followed, whether critical or analytical, the author takes no narrow view, and it will help to the understanding of the character of his book if we quote his prefatory remarks upon this subject:

> There may be an apparent inconsistency in the points of view taken in some of the legal essays. I have started sometimes from the pure analysis of the modern English school of jurisprudence, sometimes from history, sometimes from practical expediency. My own opinion is that all these methods are legitimate, and that, if their results fail to agree, it is the fault, not of the instrument, but of the worker; No doubt there exists a tendency to conflict between the historical and the analytical manner of considering legal phenomena. The historical student is tempted to regard analytical jurisprudence as shallow sciolism, while the analytical jurist is apt to charge the historical and comparative method with laxity of thought and antiquarian pedantry. Both methods are, in truth, useful and necessary, and either of them alone is imperfect; the modern developments of legal theory have shown them in their power and in their shortcomings.
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> The history of law was by no means neglected before the rise of modern critical jurisprudence; but its results were of little value so long as they could not be read in the light of general ideas and principles. Blackstone gives the history of English law from the thirteenth century onward, with sufficient fullness for all ordinary purposes, and, as a rule, with great accuracy; the historical merit of his "Commentaries" has been too much overlooked in the discussion of his faulty arrangement and inadequate theories. Montesquieu not only collects a great quantity of materials for legal history, but has a notion of historical method and comparative research far in advance of other writers of his time. Yet all this work remained unfruitful for the best part of a century. It had to be fertilized by the ideas of the analytical school. Bentham, on the other hand, had no room in his mind for history. He would have liked to make a clean sweep of all the laws and customs of Europe, and start afresh with a code warranted to secure the greatest happiness. Even language had for him no continuity to be respected. He seriously drafted specimens of legislation in a style invented by himself as the most appropriate for the purpose, and defying all the usages of common syntax. A system proceeding from this habit of mind could not easily adapt itself to the facts of different ages and societies. Its general propositions were, in truth, like those of political economy, drawn from the conditions of a particular society at a particular time, or, rather, those conditions as they would be in the absence of disturbing elements. These conditions have still their peculiar value for scientific jurisprudence, insomuch as they are those which more and more tend to be realized in the progress of modern civilized communities. But this value can not be rightly perceived, and set on its true footing, until the extreme claims of abstract analysis have broken down in the presence of unforeseen and refractory elements of fact.

Among the papers in this interesting volume we have been most impressed with those on the "Laws of Nature and Laws of Man," "The Theory of Persecution," "The Casuistry of Common Sense," and a "Review of Spencer's 'Data of Ethics.'"

A HISTORY OF THE PEOPLE OF THE UNITED STATES, FROM THE REVOLUTION TO THE CIVIL WAR. By JOHN BACH MCMASTER. In five volumes. Vol. I. New York: D. Appleton & Co. Pp. 622. Price, $2.50.

IN two provinces of thought, not formerly regarded as scientific, a powerful influence has, nevertheless, been exerted by the physical science of the present century—we refer to philology and to history. It is not the students of these subjects that have initiated the changes they have respectively undergone: the influence exerted

has been indirect, and the result of the habits of thought engendered strictly within the physical sphere. Yet so considerable has been the impression made upon these subjects in this direction, that it is much more common now than it formerly was to speak of the science of philology and the science of history.

In the case of history, other influences, no doubt, have come into play to modify it, yet the reaction of the scientific method is seen in the more rigorous scrutiny of historic evidence, in the clearer conception of a natural order in human society, and in the greater importance assigned to the environing conditions of nature. But besides this it has been the effect of science to compel a closer attention to and a higher estimate of elements formerly neglected or overlooked. Science has thus concurred with the general advance of democratic ideas in giving greater consideration to the character and interests of the common people. Macaulay was no scientist, but he was a man of sufficient breadth and sagacity to discern the unmistakable tendencies of modern thought to obliterate the old factitious distinctions between the dignified and the vulgar in historic exposition. Down to the time of this writer, history remained very much what it had always been, a chronicle of the doings of kings, commanders, diplomatists, and the ruling classes of society. He made an epoch in historic literature by first systematically taking the people into account in his delineation of the progress of historical events. His example has been inevitably followed by other authors, so that a new quality, so to speak, has been given to recent historic works. Mr. McMaster's book has been written from a thorough appreciation of the later point of view. It is a history, and the first yet attempted, of the *people* of the United States. It is said it is an imitation of Macaulay; but it is high praise to recognize it as a successful imitation of his method in a new field.

It is not, however, to be supposed that Mr. McMaster has ignored the political aspect of the history of the country, or neglected the eminent political characters that have figured in American affairs. No account of the American people would be at all sufficient that did not give prominence to their relations to government. The citizens of the United States have always been participants in the political activity of the country; more so, indeed, than has been the case in any other nation. The work before us is, therefore, necessarily to a large extent a political history, and in the first volume, now issued, we have an interesting survey of the movements of the various communities which were at length fused into a national unity by the adoption of the Constitution of the United States.

Yet that which distinguishes the work is the detailed delineation of those various social conditions, characteristics, and habits of the common people, which are both of intrinsic importance in themselves and indispensable to the understanding of the course of political action. The pictures of the social life of the people at the close of the Revolution, in the various modifications it manifested in different localities, are most instructive. The accounts of the morals and manners, education and religion, professions and industries, the diet and dress of the people, their ideas and prejudices, the conflicts of sects and parties, the condition of cities, and the particulars of country life, in short, all the circumstances by which the complexion of society was affected, are described with a freshness of illustration which shows the most indefatigable and extended research into all available sources of information upon the subject.

This characteristic alone would give a fascinating interest to Mr. McMaster's volume, but that interest is greatly enhanced by the clearness, directness, simple earnestness, and often the eloquence of his style. This history is emphatically a book for the people, not only in the import and adaptation of its subject-matter, but in its thoroughly popular literary form. It is a book to please everybody. History here descends from its rhetorical stilts, and uses the plain vernacular of common sense, without abating a jot of its attractiveness. There is no fine writing, no straining after effect, because the interest of the topics is abundantly sufficient to maintain the reader's attention. We congratulate the author on the success of his undertaking, and all his readers on the pleasure they will have in perusing his book.

PHARMACEUTISCHE RUNDSCHAU. (Pharmaceutical Review.) Published by Dr. Fr. Hoffmann, 64 Ann Street, New York. Monthly. Pp. 24. $2 a year.

THIS new publication, conducted by a gentleman of the best standing in his profession, starts out with the promise of being a journal of a high order and a valuable addition to the literature of scientific specialties. It is devoted to the scientific and professional interests of pharmacy and kindred branches in the United States, and labors with well-directed vigor in every department for the maintenance and elevation of the standard of scientific attainment in its profession. The February number contains editorial articles on "Pharmacy and Public Sanitary Conditions," and "Pharmacy and Homœopathy." In the March number the editor, under the heading "Kurpfuscherei?"—which we might translate "Cure-bungling"—presents a well-considered and well-tempered discussion of the propriety of allowing apothecaries to dispense medicines, and of requiring them to qualify themselves to do so with discretion. The two numbers contain original contributions on the testing of liquorice-juice and of quinine-pills, sorghum-sugar, mass-analysis, the "Pharmacopœia of the United States," and the preparation of medicinal doses by compression. A considerable part of each number is occupied with the systematic presentation in a compressed form of notable facts in the progress of the science as currently recorded in the various journals of this and other countries, and to the proceedings of pharmaceutical societies and associations.

WHENCE, WHAT, WHERE? A VIEW OF THE ORIGIN, NATURE, AND DESTINY OF MAN. By JAMES R. NICHOLS, M. D., A. M., Editor of "The Boston Journal of Chemistry." Third edition, revised. Boston: A. Williams & Co. Pp. 198. Price, $1.

THIS thoughtful volume consists of inculcations, reflections, and speculations touching those questions of the origin, nature, and destiny of man that have ever been regarded as of transcendent interest. How man has originated, what is the true constitution of his being, and how he stands related to the great indefinite future, are inquiries that, on the one hand, find simple answers in the beliefs of uninstructed people, and which, on the other hand, have tasked the highest philosophy of all ages, with no final agreement. But, although there remains, perhaps, as much conflict as ever over these problems, it would be wrong to say that the outcome of inquiry in all these directions has been futile. Certainly, as regards the whence and the what of humanity, a great deal is now known of which men in earlier times were profoundly ignorant. Man's nature—that is, the laws of his constitution—has been studied with fruitful results, and the laws and the knowledge thus obtained have thrown a not entirely uncertain light upon the question of his origin. Of one thing we have positive assurance: the order of phenomenal nature, of which man is a part, is no inscrutable secret; it is open to the research of reason, and it is capable of being understood as far as the nature of human intelligence will permit. The field is, therefore, open in which we may verify and extend the inquiries already begun in regard to what man essentially is and whence he has originated—the field of orderly, phenomenal, explorable nature.

But there are those—and they are possibly more numerous in these days than ever before—who maintain that man is shut into the present sphere by inexorable limits, and that, while he remains the being he is, he can never know that which is beyond the cosmical sphere of his observation and experience. They hold that this human intelligence is finite, and therefore by its quality is restricted to finite things, and can never grasp what is beyond the finite. They claim that, in its very essence, knowing is but a recognition of finite relations; that mind itself has been evolved and constituted by intercourse with nature, and is without capacities to deal with any other sphere of being. They insist that, as the human mind is finite and limited, it must stop somewhere by virtue of inherent incapacity, and that this boundary is the phenomenal sphere of being. That there may be other orders of being, and other universes beyond, they do not deny; but they say that our relations to them can never include a knowledge of them in the sense in which the term knowledge is applied to the surrounding order of things.

But the protest against this circumscrip-

tion of the human mind is ancient, universal, and very deep in human nature. It is held that man has as much right to be measured by his aspirations as by any other of his psychical traits, and that he has reaches of intuition and inspirations of insight that will not be hemmed in by his transient experiences of time and space. They say he has a bodily organism by which he is confined to a very narrow area upon the little planet which he inhabits, but that, nevertheless, in virtue of his higher capacities, he makes himself at home in a universe of which he can nowhere find the limit, and they hold that this fact gives high assurance that there may be still vaster possibilities and extensions in the ever-unfolding future.

The author of the little book before us belongs to this class which refuse to be shut in by the material limitations of the surrounding world. While admitting that science is phenomenally circumscribed, they hold that the unknown may not be exhausted by its methods. The book is a quiet but earnest presentation of the considerations which, in the mind of the writer, are sufficient to justify a steadfast faith in man's immortal future. It is impossible here to give any synopsis of the course of Dr. Nichols's reasoning; but those who are interested in its line of thought will find that its arguments are ingenious and instructive, and by many they will undoubtedly be regarded as cogent and valid. But they are not put forward in any dogmatic spirit. They aim simply to be suggestive and helpful, and from this point of view there are multitudes who will find them satisfactory.

BULLETIN OF THE ARCHÆOLOGICAL INSTITUTE OF AMERICA. I. January, 1883. E. H. Greenleaf, Secretary. Boston: A. Williams & Co. Pp. 40.

THE work of the Institute was carried on at the ancient Greek city of Assos, in Asia Minor, during the spring, summer, and autumn of 1882, with fruitful and interesting results. The explorations, not yet completed, will be continued during the present year, till the expiration of the permission which has been accorded by the Turkish Government. It is probable, the report states, that, when all is done, "the remains at Assos will not only present the most perfect idea of a Greek city that is anywhere to be obtained, but will afford a better insight into the life of an antique city than is to be gained even from the streets and houses of Pompeii." Mr. Ad. F. Bandelier presents an interesting summary of his work in New Mexico, chiefly among the ruined pueblos, and outlines the plan of a journey of archæological exploration which he is now making through the comparatively unexplored regions of the Mexican border.

ON THE LOESS AND ASSOCIATED DEPOSITS OF DES MOINES. By W. J. MCGEE, of Farley, Iowa, and R. ELLSWORTH CALL, of Des Moines, Iowa. New Haven, Connecticut: Tuttle, Morehouse & Taylor, Printers. Pp. 24.

WE have here a careful study in local geology and physical geography, from which interesting conclusions are drawn respecting the contour of the glacial terminal moraine and the conditions under which the drift-deposits were accumulated in the region of Des Moines. The peculiar fact is brought out that the rivers in this region have avoided low-lying plains and sought elevated plateaus and ridges of both sedimentary rocks and quaternary deposits, and that their general course is at right angles to the mean slope of the surface which they drain.

"PAPILIO." A Monthly Journal, devoted solely to Lepidoptera. HENRY EDWARDS, Editor, 185 East 116th Street, New York. Price, $2 a year.

THE publication of this journal has now been continued for over two years, the first number having appeared in January, 1881. During this time it has contained articles upon the insects within its scope, by the most distinguished entomologists in Europe and the United States. The two volumes that have been completed contain, together, about 430 pages of matter and six colored lithographs, besides several woodcuts of interest. As occurs in the early career of most natural history publications, this magazine has entailed upon its projectors a heavy loss. But they are still full of hope, and urgently ask of all who recognize the importance of such a publication, that such help as can be afforded may be freely given, in order that so excellent a labor may not

be allowed to languish for the want of a little support at a critical period.

Admirable papers on subjects connected with Lepidoptera are either in hand or promised by their authors for the present volume. Each monthly part contains from eighteen to twenty-five pages, and at least four colored plates will be given during the year. For its aims, value of its articles, and general appearance, "Papilio" is one of the cheapest scientific publications in the world, and its directors promise that nothing shall hereafter be wanting on their part to maintain it in the high position to which it aspires.

A PRACTICAL TREATISE ON DISEASES OF THE SKIN. By LOUIS A. DUHRING, M. D., Professor in the Hospital of the University of Pennsylvania. Third edition, revised and enlarged. Philadelphia: J. B. Lippincott & Co. Pp. 685. Price, $6.

THIS is a competent and comprehensive work that admirably fulfills the aim with which the author says he set out, "to write a concise and practical treatise, one which, while making no pretensions to being exhaustive, should comprise sufficient to afford a clear insight into the elements of dermatology, and a knowledge of the important facts in connection with each disease treated of." Simplicity and intelligibility have been primarily sought, and therefore questions of theory, discussions of unsettled points, and obsolete terms have been avoided. The classification of Hebra has been adopted, with some changes and modifications. The definitions of the diseases have been made from the clinical stand-point, with a view to giving them practical value, and to having them embody succinct descriptions of characteristic symptoms. In the matter of treatment, the methods favorably regarded by dermatologists at large have been mentioned, and the author has furthermore taken the pains to describe the remedies and mode of treatment which have proved of the greatest benefit in his own experience. The work was considerably enlarged in the second edition, with many additions and new chapters, and was entirely rewritten to meet the remarkable progress which had been made in the science of dermatology during the five years since the first edition was published, in 1876. Then, in a little more than another year, a critical revision was called for, with a rewriting and elaboration of the chapter on the anatomy and physiology of the skin, for the sake of incorporating the later results of the studies in microscopic anatomy. Advantage was taken of the revision to introduce additional cases illustrating rare forms of disease, and new and important observations and personal experiences. The method and arrangement of the treatise deserve commendation. The general considerations of the subject are given in the first part under the headings "Anatomy and Physiology," "Symptomatology," "Etiology," "Pathology," "Diagnosis," "Treatment," "Prognosis," and "Classification." The second part is devoted to the account of special diseases, which are classified as "Disorders of Secretion," "Hyperæmias," "Inflammations," "Hæmorrhages," "Hypertrophies," "Atrophies," "New Growths," "Neuroses," and "Parasites." In connection with each disease are given its synonyms, a general description in a sentence, its symptoms, diagnosis, etiology, pathology, prognosis, treatment, and, when proper, illustrations. The curious facts are brought out by the author that skin-diseases manifest variations of type in different parts of the world; that the differences are quite material between the United States and Europe; and that the diseases met with here resemble more closely those of Great Britain than those of either France or Germany. These facts give the work the more value as an American treatise describing American types of disease.

A DICTIONARY OF ELECTRICITY; OR, THE ELECTRICIAN'S HAND-BOOK. By HENRY GREER. 1883. Pp. 192. Price, $2. To be obtained of the author, College of Electrical Engineering, 122 East Twenty-sixth Street.

THE STORAGE OF ELECTRICITY. By the same. 1883. Price, $1.

MR. GREER hopes, in the preface to his dictionary, that "the explanations may meet the wants of students and others engaged in these professions" (electrical and telegraph engineering), and it may be presumed that such was his object in preparing it; but had he been attempting instead to crowd the greatest amount of rubbish possible into the least space, he would have had no

occasion to depart widely from his present performance. One example—his description of the Edison steam-dynamo—will suffice to show the accuracy and lucidity of the definitions of this remarkable dictionary:

DYNAMO-MACHINE, EDISON'S LARGE.—This is a machine directly in the piston of an engine, and is composed of four electro-magnets, the poles, and with pipes for the circulation of air. The machine and Porter & Allen's engines are all built on a cast-iron base, the whole weighing about twenty-two tons. The field-magnets are of cast-iron, and the resistance varies between one and two ohms. The magnets are wound with No. 10 wire, Brown and Sharp gauge. The enormous pole-pieces are of cast-iron, and Edison maintains the necessity for using such pole-pieces. The armature consists of a steel shaft six inches in diameter. Mr. Edison and many other electricians claim that a low-resistance machine is the best form. Edison's latest dynamo-machine has a resistance of one two-thousandth of an ohm. Ninety-seven per cent of the electricity out of the machine is available.

The pamphlet on the storage of electricity has the advantage of the dictionary in that Mr. Greer's work consists in little more than editorial revision. The pamphlet contains a good part of Professor Sylvanus Thompson's excellent lecture before the Society of Arts on the storage of electricity, the advantage of the storage-battery as set forth in the circular of the Brush-Swan Company, and the statement of the value of the Faure battery given in the circular issued by the American company controlling this apparatus, together with descriptions of various other storage-batteries, some taken from different technical journals, and some written by Mr. Greer.

ON PREHISTORIC TREPHINING AND CRANIAL AMULETS. By ROBERT FLETCHER, Acting Assistant-Surgeon, United States Army. Washington: Government Printing-Office. Pp. 32, with Nine Plates.

THOUGH published as one of the documents of the Powell Geographical and Geological Survey, the matter of this monograph is more European than American, but is susceptible of an American application. The author has aimed, starting from Broca's summary of the subject in 1877, to collect the accounts of discoveries of examples of trephining and cranial amulets scattered through the journals of anthropology, not only on account of their interest in themselves, but also for the sake of the illustration and guidance they may afford in American research. Numerous curious instances of the practice of trephining and the fabrication of amulets are brought to light, and the conclusions are adduced that the large number of perforated crania, exhibiting cicatrized edges, establishes the existence of a custom of trephining; that the operation was performed on both sexes, and generally at an early age; that it seems (from analogy) to have been for the relief of disease of brain, injury of skull, epilepsy, or convulsions; that it was probably performed by scraping, possibly by a series of punctures; that posthumous trephining consisted in removing fragments of the skull of a person who had undergone surgical trephining, in which each fragment was probably to form an amulet to protect from the same disease or injury for relief of which the operation had been performed; and that the evidence so far confines the custom to neolithic man on the Continent of Europe.

THE NAVAL USE OF THE DYNAMO-MACHINE AND ELECTRIC LIGHT. By Lieutenant J. B. MURDOCK, U. S. Navy, U. S. Naval Institute, Annapolis, Md. Pp. 44.

IN this paper, Lieutenant Murdock has collected and compiled from the current scientific literature of the day such information bearing on the subject as will enable one to reach a more exact comprehension of the field open for the electric light in modern naval warfare. The applicability of the various machines and apparatuses that have been introduced is discussed, and the modifications are considered that may be necessary to adapt them to use on shipboard.

"THE SOCIOLOGIST." A Monthly Journal devoted to the Increase of Knowledge of the Natural Laws that control Human Happiness. Adair Creek, Knox County, East Tennessee: A. Chavannes & Co. Pp. 16. Fifty cents a year.

THE publication of this journal has been undertaken for the love of the cause. The editor has sought for a paper especially devoted to the study of sociology, and, not finding it, has decided to furnish one. Profit is not the especial object of the publishers, but to create a means of communication and a means of exchange of thoughts and opinions.

"JOURNAL OF SOCIAL SCIENCE," CONTAINING THE TRANSACTIONS OF THE AMERICAN ASSOCIATION, December, 1882. Saratoga Papers of 1882. Boston: A. Williams & Co. New York: G. P. Putnam's Sons. Pp. 164. $1.

THE present number of the "Journal" contains, besides the opening address of the President of the Association, Professor Francis Wayland, and the report of the General Secretary, the papers read at the meeting in the Health and the Social Economy Departments. Among the papers in the former department we notice especially those of Dr. Ezra M. Hunt, on "The Health Care of Households, with Especial Reference to House Drainage"; of Dr. D. F. Lincoln, on "The Health of Boys' Boarding-Schools"; of Dr. E. M. Mosher, on "The Health of Criminal Women"; and of Dr. A. N. Blodgett, on "The Management of Chronic Inebriates and Insane Drunkards." Two papers in the Social Economy Department, those of Mrs. Robinson on "Early Factory Life in New England" and Lucy Larcom on "American Factory Life," depict a condition of life and intelligence among factory-operatives, and relations between employers and employed, which Americans were once proud of, and foreigners admired, but which have now — thanks largely to the protective policy — become things of the past, and which we can hardly hope to enjoy again.

ON THE VALUE OF THE "NEARCTIC," AS ONE OF THE PRIMARY ZOÖLOGICAL REGIONS. By Professor ANGELO HEILPRIN. Philadelphia. Pp. 20.

THE "Nearctic," in Messrs. Sclater and Wallace's classification, corresponds with the North American zoölogical region, as distinguished from the Palæarctic or Eur-Asian, and the Neotropical, or South American, regions. The question under discussion is "whether the Nearctic region should be kept separate, or whether it should form part of the Palæarctic or of the Neotropical regions." Eminent authorities differ on the subject. Professor Heilprin makes an examination, by families, genera, and species, of the mammalia, birds, reptiles, and partially the butterflies and mollusca of the three regions, inquiring how many of each are common to the Nearctic and one of the two others, and to which of the two; and concludes "that, by the community of its mammalian, batrachian, and reptilian characters, the Nearctic fauna . . . is shown to be of a distinctively Old World type, and to be indissolubly linked to the Palæarctic (of which it forms only a lateral extension)." The conclusion is further illustrated by the mollusca and the butterflies.

DEPARTMENT OF AGRICULTURE: REPORT OF THE ENTOMOLOGIST FOR THE YEAR ENDING JUNE 30, 1882. By CHARLES V. RILEY, M. A., Ph. D. Washington: Government Printing-Office. Pp. 168, with Twenty Plates.

THE present report, which necessarily covers only a small part of the work actually done in the entomologist's office, is devoted to some of the more important observations and experiments of a practical nature on such subjects as the cultivation of pyrethrum and its use as an insecticide, silk-culture, the cotton-worm, the chinch-bug, the army-worm, the insects affecting the orange and those affecting rice, some new depredators on corn, and various miscellaneous insects that attracted more than usual attention during the year. The large number of letters, asking for information, received at the office, has led to the preparation of bulletins on special subjects to be sent out. Such bulletins are ready on the Northern army-worm, the boll- or corn-worm, and canker-worms, and others are in preparation on cabbage-insects and the chinch-bug. Three special reports, which will be more bulky, are in preparation — a bibliography of economic entomology, and reports on the insects affecting the orange-tree, and forest-tree insects.

BULLETIN OF THE BUFFALO NATURALISTS' FIELD CLUB. Vol. I. Nos. 1 and 2. Charles Linden, President; George S. Wardwell, Corresponding Secretary. Buffalo, N. Y.: W. W. Hicks, Printer. Bimonthly. Pp. 48. Price, $1 a year.

THE club was organized in 1880, and has shown great vitality and enlisted much interest. Being in a condition to establish a periodical of its own, and that seeming desirable, it has originated the "Bulletin," the plan of which is to publish brief summaries of general papers read at the winter meetings of the club, short original papers, or

memoirs on all branches of natural science, and notes on the occurrence and habits of local plants and animals. While practical work and research are especially cultivated and encouraged, the æsthetic is not disdained, and we find the "Bulletin" as bright on that side as it is instructive on the other. Among the papers which may be mentioned as of general interest are Mr. Cowell's study of the "Adventives"—plants that have been brought, by the railroads and other means, from distant points—that have made their appearance in the stock-yards at East Buffalo, and Professor Linden's account of prominent objects of scientific interest within convenient access of the city and its neighborhood.

REPORT OF AN EXPLORATION OF PARTS OF WYOMING, IDAHO AND MONTANA, in August and September, 1882, made by Lieutenant-General P. H. Sheridan. Washington: Government Printing-Office. Pp. 69.

THE report is accompanied by the itinerary of Colonel James F. Gregory, and a geological and botanical report by Surgeon W. H. Forwood. The expeditions centred around the Yellowstone National Park. General Sheridan recommends an enlargement of the park by extending it about forty miles east and ten miles south, and making it a national game reservation, within which the killing of game shall be prohibited. Colonel Gregory's journey resulted in a demonstration of the practicability of the route into the park from the forks of Wind River, by way of Lincoln Pass, the valleys of the Gros Ventre and Snake Rivers and Lewis's or Lake Fork of the Snake River. Surgeon Forwood's report illustrates the general features, natural history, and resources of the regions explored.

THE PLACE OF ORIGINAL RESEARCH IN COLLEGE EDUCATION. By JOHN HENRY WRIGHT, Associate Professor of Greek in Dartmouth College. Boston: Alfred Mudge & Son, Printers. Pp. 29.

"ORIGINAL RESEARCH," as used by the author in connection with a college education, means chiefly work pursued in subjects embraced in college instruction; and, inasmuch as the major part of the college course is made up of linguistic, literary, historical, and philosophical studies, the topics of inquiry are ordinarily drawn from those fields, as well as from physical science, in connection with which the term is more commonly used. The essential character of the work is that it consists in and is based upon direct personal observation and actual examination, together with inductions suggested by the facts investigated and discovered, made independently by the inquirer and without outside help. In the recorded results of the studies, the matter of chief consequence will be the earnest, independent work, the exact observation, and the hard thinking that they represent. The manner in which research of this kind is furthered and encouraged at the German universities and seminaries is described; the question whether similar methods can be applied at American institutions is answered in the affirmative; and observations and suggestions are added as to the manner in which the applications may be made.

A STUDY OF THE MANUSCRIPT TROANO. By CYRUS THOMAS, Ph. D. With an Introduction by D. G. BRINTON, M. D. With Nine Plates. Washington: Government Printing-Office. Pp. 236.

THIS is an attempt to give intelligibility to one of those mysterious documents which have been left to us from the former masters of Central America; from the people who probably built some of the cities the ruins of which are numerous in that region, and were the authors of the inscriptions of Palenque. The manuscript, or Codex Troano, was so called by the Abbé Brasseur de Bourbourg, after the gentleman, Don Juan de Tro y Ortolano, of Madrid, a descendant of Hernando Cortez, in whose possession he found it. It is written, like the two other Maya codexes which have been chromo-lithographed and published, on paper manufactured from the leaves of the maguey plant. In form, it was folded into thirty-five folds, like the panoramic books of illustrations or "souvenirs," which are sold at the watering-places, and was written on both sides of the folds, giving seventy pages. The inscriptions consist of lines and columns of characters and numerals occupying the top and left side of the page, and inframing, in the rest of the space, symbolical or descriptive figures. Dr. Thomas, who acknowledges that his investigation is not as complete as he

would desire, but deems it best to give the results tentatively, concludes that the work was intended chiefly as a ritual or religious calendar, to guide the priests in the observance of religious festivals, in their ceremonies, and in other duties; that the figures in the spaces are symbolical or pictographs, and refer to religious ceremonies or to the habits, customs, and occupations of the people; that the work appertained to an inland, peaceable, and sedentary people; and that the original of it was written in about the middle or latter half of the fourteenth century. Dr. Brinton gives, in his introduction, a summary of what is known respecting the Maya language and writings, which, it must be borne in mind, are quite distinct from those of the Aztecs. Two other Maya manuscripts have been published in chromo-lithography, but no attempt appears to have been made to decipher them, and several are believed to exist in private hands. In addition to the manuscripts, we have the mural paintings and inscriptions of Palenque, Copan, Chichen Itza, and other ruined cities, of the same general character. The use of the Maya mode of writing ceased after the Spanish conquest, on account of the intolerance of the priests, but many books were written by natives in their own language with the Spanish alphabet, a number of which still exist.

THE ELEMENTS OF FORESTRY. By FRANKLIN B. HOUGH, Ph. D., Chief of Forestry Division, United States Department of Agriculture. Cincinnati: Robert Clarke & Co. Pp. 381. With numerous Illustrations. Price, $2.

THIS work is designed to afford information concerning the planting and care of forest-trees for ornament or profit, and to give suggestions upon the creation and care of woodlands, with the view of securing the greatest benefit for the longest time; and is particularly adapted to the wants and conditions of the United States. The author believes it to be the first attempt to present, in our language, and in one volume, the subject of forestry in the comprehensive sense in which he has defined it. He has endeavored to adapt the work to the wants of students of the subject, whether they be in the class-rooms of an institution, or engaged in practical labors, and to present information applicable to our own country, and to those regions where tree-planting is most needed, and often most difficult. The matter of the treatise has been admirably condensed, so that the volume is made to contain an amount of information, all of practical bearing and well expressed, that might have been made to fill two or three times the space without appearing "padded." Besides reviewing the general principles of forest botany, forestry, and the growth of trees in their various aspects, it includes chapters on the reproduction of trees from seed, and by other methods; the best manner and systems of planting; special suggestions on ornamental planting, and planting for hedges, screens, and shelter-belts; forest-fires, and protection from them, and from other sources of injury; the ravages of insects; the profit of forest cultivation; the acts of Congress in reference to timber-rights; European plans of forest management; the cutting and seasoning of wood, defects in timber and processes for increasing the durability of timber and improving its quality; the various products obtained from wood and trees; descriptions of particular species of trees, their uses and adaptations; with a special chapter on the conifers; and tree-planting in Kansas and Nebraska — the whole constituting a treatise at once scientific and practical.

THE AMERICAN JOURNAL OF FORESTRY. Vol. I. Nos. 1, 2, and 3, October, November, and December, 1882. Edited by FRANKLIN B. HOUGH, Ph. D. Cincinnati: Robert Clarke & Co. Pp. 48 each. Price, $2 a year.

THIS new publication is devoted to the interests of forest-tree planting, the formation and care of woodlands and ornamental plantations generally, and to the various economies therein concerned, and comes very appropriately when public attention is called to the subject by a dozen different influences and agencies. The present numbers are occupied to a considerable extent with the proceedings of the American Forestry Congress, at its Cincinnati and Montreal meetings, and publish some of the valuable papers that were read there. One of the most noticeable papers is that of Mr. Charles Mohr, of Mobile, Alabama, on the

"Distribution of the more Important Forest-Trees in the Gulf Region." The editor contributes observations in forestry matters made by him during a recent journey in Europe; Professor Spalding, of Ann Arbor, a paper on "Forestry in Michigan"; and Dr. Warder, of Ohio, accounts of experimental forest plantations in Iowa and near Waukegan, Illinois.

THE SCIENTIFIC AND TECHNICAL READER. London, Edinburgh, and New York: T. Nelson & Sons. Pp. 400. Price, 2*s.* 6*d.*

THE "Reader" is a compendium of brief selections in different departments of science, usually from standard authors, arranged so as to present a general order of collection, and designed to instruct the reader on the subjects discussed in an agreeable manner. The selections are classified and arranged under the heads "Geographical," "Geological," "Botanical," "Zoölogical," "Physiological," "Physical," and "Technical."

TABLES FOR THE USE OF STUDENTS AND BEGINNERS IN VEGETABLE HISTOLOGY. By D. P. PENHALLOW, B. S. Boston: S. E. Cassino. Pp. 41. (With blank pages for notes.)

THIS work was first conceived as an aid to the author's own students in vegetable histology. It has been prepared with the aim to bring together the most prominent facts and reactions of an elementary course of histology in such a manner that the student may have them on his work-table ready for immediate and constant reference, and may use them as a general guide. The work being tentative, it has been deemed desirable not to make it too extended till the plan has been approved by qualified judges.

TRANSACTIONS OF THE LINNÆAN SOCIETY OF NEW YORK. Vol. I. New York: Published by the Society. H. B. Bailey, Corresponding Secretary. Pp. 168. Price, paper, $2; cloth, $3.

THE Linnæan Society of New York was formed in 1878, with eleven members, and was organized with Clinton Hart Merriam as president; Harold Herrick as vice-president; and Ernest Ingersoll as secretary. Abstracts of its proceedings and various papers read before it have appeared in different scientific serials, but it has felt the need of a direct medium of publication. The outgrowth of that need is the present volume, executed in the highest style of the printer's art, with thick paper and wide margins—a volume worthy of the objects of the society, and of the valuable and interesting papers which it contains. The papers are: "The Vertebrates of the Adirondack Region, Northeastern New York (General Introduction—Mammalia; Carnivora), by Clinton Hart Merriam, M. D.; "Is not the Fish-Crow (*Corvus ossifragus*, Wilson) a Winter as well as a Summer Resident at the Northern Limit of its Range?" by William Dutcher; and "A Review of the Summer Birds of a Part of the Catskill Mountains, with Prefatory Remarks on the Faunal and Floral Features of the Region," by Eugene P. Bicknell. The volume is adorned with a steel-plate portrait of Linnæus, from an old engraving in the possession of Mr. L. S. Foster, as a frontispiece.

ANSICHTEN ÜBER DIE URSACHEN DER VULCANE (Opinions on the Causes of Volcanoes). Pp. 6. NEPTUNISCH ODER PLUTONISCH? (Neptunian or Plutonian?) Pp. 14. Both by Ed. Reyer, Vienna.

THE first of these papers is a review of the three theories—those of interior heat, chemical action, and mechanical action—of the origin of volcanoes, with a discussion of the causes of eruptive phenomena and outbreaks. The second essay considers the relations of granite, porphyry, and lava, and the origin of granite.

THE FOUNDATION PRINCIPLE OF EDUCATION BY THE STATE. By SAMUEL BARNETT. Boston: New England Publishing Company. Pp. 11.

THIS pamphlet includes the substance of an address delivered before the joint session of the National Teachers' Association and the National Institute of Instruction at Saratoga, in July last. The purpose of the address is to show the close connection between the educational development of citizens and the welfare of the State, and the interest the State has in seeing that educational facilities are provided and improved.

FOREST PROTECTION, AND THE TARIFF ON LUMBER. New York: Spirit of the Press. Pp. 35.

THE whole country is suffering to an increasing extent every year from the disastrous effects of the removal of the forests; and the best economical thought of the nation is busy with the problem of preventing further destruction, and repairing the damage that has already been done. Yet the Government, in imposing a tariff on foreign lumber, is offering a premium for further destruction and a direct encouragement to a continued course of ruin. Vigorous expressions of public opinion against this senseless policy have been made through various journals. The most important of the protests are collected in this pamphlet in aid of a fuller discussion and better understanding of the subject, and for the furtherance of measures for forest conservation.

ANNUAL REPORT OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR 1882. Address, New Haven, Conn. Pp. 114.

THE station was removed on the 1st of September last, from the rooms of the Sheffield Scientific School to the property of five acres, which had been bought for it on Suburban Street, nearly a mile and five eighths from the City Hall of New Haven. The analyses were interrupted at that time, yet nearly the usual number of fertilizer analyses were made during the year, and of these a large proportion were on samples of complex composition. In connection with analyses of salt and saltpeter at the request of the Wilton Farmers' Club, the use of those substances as antiseptic or preservative material is discussed. The testing of milk has assumed much prominence; and in connection with it considerable information of value is furnished respecting the qualities of the specimens examined. In connection with the reports of the analyses of fertilizers, a review of the fertilizer market is given, with notices of the prices of its principal staples; and an interesting observation is reported of the value of marine mud as a fertilizer. The reports on the analyses of ensilage go to confirm, generally, the representations previously made of the value of that preparation. Interesting information and suggestions are given in connection with the seed-tests, of which twenty-four were made, mostly on sweet-corn and onion-seed.

SEED-BREEDING. By E. LEWIS STURTEVANT, M. D., South Framingham, Mass.

THE art of breeding seeds consists in producing and selecting such variations as may be found desirable, and then of establishing them so that they shall be transmissible either in their present or in an improved condition, by seed. Breeding may be carried on through the act of selection for several generations under well-considered conditions of environment, by which the heredity of the seed in the desired direction shall be strengthened. Particular attention is given in this pamphlet to the means by which the best selections of seed-corn may be developed, and established in character.

REPORT ON THE DEVELOPMENT OF THE MINERAL, METALLURGICAL, AGRICULTURAL, PASTORAL, AND OTHER RESOURCES OF COLORADO FOR 1881 AND 1882. By J. ALDEN SMITH, State Geologist. Denver, Col.: Chain & Hardy. Pp. 159.

THE report claims that, by virtue of the largest returns, Colorado is the head of the mining states of the world as a producer of the precious metals. Its mines have also, for the past two years, furnished more than half the total lead product of the United States. The mining field is very large, embracing nearly all the mountain-ranges, and is extremely inviting to all persons interested in that pursuit. The report is well arranged, and gives in succession a history and description of the railroads of the State, accounts of the resources of the several counties, more general notices of certain mineral and agricultural staples and industries, and a systematic descriptive catalogue of the principal minerals in Colorado.

THE MANUAL TRAINING-SCHOOL OF WASHINGTON UNIVERSITY, ST. LOUIS, 1882–'83. C. M. Woodward, Secretary. Pp. 45.

THE managers of this school do not assume that in other schools there is too much intellectual and moral training, but that there is too little manual training for ordinary American boys. They exact close and thoughtful study with books, as well as with

tools; but by abridging a little the number of daily recitations and adding an hour to the usual school-day, they find time for drawing and tool-work. Besides the usual literary training, the students are given a course of tool-instruction, including carpentry, wood-turning, forging, soldering, and bench and machine work in iron, for which shops are conveniently fitted up, and free-hand and mechanical drawing. Each pupil before receiving a diploma must execute a project—the actual construction of a machine, with a full set of working drawings—satisfactory to the faculty. By the peculiar course pursued, the zeal and enthusiasm of the students, in all the departments of the work, have been developed to a most gratifying extent.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Astronomical Photography, pp. 2; Circulars relative to the Collection and Distribution of Astronomical Intelligence, pp. 7; Observations of the Transit of Venus at Harvard College Observatory, pp. 28; Thirty-seventh Annual Report of the Director of the Astronomical Observatory of Harvard College, pp. 15. All by Edward C. Pickering. Cambridge, Massachusetts: University Press.

The Soul and the Body. A Sermon to Medical Students. By the Rev. L. P. Mercer. Chicago: Gross & Delbridge. Pp. 31.

Perpetual Calendar. By President F. A. P. Barnard, Columbia College, New York.

The Garden of Eden (Victoria Woodhull's lecture). Reviewed by Charles Stuart Welles. London. Pp. 30.

"The Freethinkers' Magazine, and Freethought Directory, for the United States and Canada." H. L. Green, Editor and Publisher. Salamanca, New York. Bimonthly. Pp. 44.

The Charge of "Exclusivism" as applied to Homœopathists. By F. H. Orme, M. D. New York. Pp. 8.

Natural Law, or the Science of Justice, pp. 21; A Letter to Thomas F. Bayard, pp. 11. Both by Lysander Spooner. Boston, Massachusetts.

Annual Report of the State Geologist of New Jersey for 1882. By George H. Cook. New Brunswick. Pp. 191, with Plates.

Lectures delivered to the Employés of the Baltimore and Ohio Railroad Company. By Professor H. N. Martin, and Drs. H. Sewall, W. T. Sedgwick, and W. H. Brooks, of Johns Hopkins University. Baltimore: B. & O. R. R. Co. Pp. 98.

Establishment of Secondary Meridians in the East Indies, China, and Japan. Washington: U. S. Hydrographic Office. Pp. 4.

The Pine Moth of Nantucket. By Samuel H. Scudder. Boston: A. Williams & Co. Pp. 22, with a Plate.

"Transactions of the New York Academy of Sciences." Monthly. Pp. 24 $5 per annum.

Annual Address before the American Academy of Medicine, Philadelphia, October, 1882. By Traill Green, M. D., President. Philadelphia. Pp. 16.

The Percentage of College-bred Men in the Medical Profession. By Charles McIntire, Jr., M. D., of Easton, Pennsylvania. Pp. 13.

Iowa Weather-Service Annual. Illustrated. 1883. By Gustavus Hinrichs. Iowa City, Iowa.

Shade-Trees, Indigenous Shrubs, and Vines. By J. T. Stewart, M. D. Peoria, Illinois. Pp. 37.

Dime Question Books. Algebra. By Albert P. Southwick. Syracuse, New York: C. W. Bardeen. Pp. 41. 10 cents.

Illustrations of the Durham System of House-Drainage. New York: Durham House-Drainage Company. Pp. 24.

Houghton Farm Experiment Department. Meteorology and Soil Temperatures. By D. P. Penhallow, B. A. Newburg, New York: Ritchie & Hull. Pp. 57, with Plates.

Maternal Schools in France, pp. 14; Technical Instruction in France, pp. 63. (Circulars of Information of the Bureau of Education.) Washington: Government Printing-Office.

The Selective Absorption of Solar Energy. By S. P. Langley, Allegheny College. Pp. 28, with Plates.

Safety on Land and Sea. By Dr. W. F. Thoms. New York: Published by the Author, 92 Madison Street. Pp. 29.

On some Inclosures in Muscovite. By H. Carvill Lewis, of Philadelphia. Pp. 6, with One Plate.

Surgical Diseases of Women. By Romaine J. Curtiss, M. D., of Joliet, Illinois. Pp. 7.

College of Physicians and Surgeons of Chicago. Announcement. 1883. Pp. 8.

The Early American Chroniclers. By Hubert Howe Bancroft. San Francisco: A. L. Bancroft & Co. Pp. 45.

How can we escape Insanity? By Charles W. Page, M. D., of Hartford, Connecticut. Pp. 22.

The Order of Mental Disorder. By Orpheus Evarts, M. D. College Hill, Ohio. Pp. 8.

Monthly Weather Review (U. S. Weather Service). Washington: Office of the Chief Signal Officer. Pp. 23, with Four Plates.

Consultation Chart of the Eye Symptoms and Eye Complications of General Diseases. By H. G. Cornwell, M. D. Columbus, Ohio: H. C. McClelland & Co. P. 1.

"The Jeweler's Circular and Horological Review." D. H. Hopkinson, Editor and Proprietor. 42 Nassau Street, New York. Monthly. Pp. 88. $2 a year.

Pocket Logarithms to Four Places of Decimals, etc. New York: D. Van Nostrand. 1883. Pp. 139. 50 cents.

American Humorists. By Rev. H. R. Haweis, M. A. New York: Funk & Wagnalls. 1882. Pp. 1805. 75 cents.

Studies in Logic. By Members of the Johns Hopkins University. Boston: Little, Brown & Co. 1883. Pp. 208. $2.

The Alternative: A Study in Psychology. London: Macmillan & Co. 1882. Pp. 387. $2.75.

The Diadem of School Songs. By W. M. Tillinghast. Syracuse, New York: C. W. Bardeen. Pp. 160. 50 cents.

Wealth Creation. By Augustus Mongredien, with Introduction by Simon Sterne. New York, London, and Paris: Cassell, Petter, Galpin & Co. 1883. Pp. 308. $1.25.

Science in Short Chapters. By W. Matticu Williams. New York: Funk & Wagnalls. 1883. Pp. 308. $1.

Our Choir. By C. G. Bush. New York: G. P. Putnam's Sons. 1883. Pp. 20. Illustrated.

Leading Men of Japan. By Charles Lanman. Boston: D. Lothrop & Co. 1883. Pp. 421. $2.

Bulletin of the United States Fish Commission, vol. I, for 1881. Washington: Government Printing-Office. Pp. 465.

A Manual of Chemical Analysis. Third edition, revised and enlarged. By Frederick Hoffmann, A. M., Ph. D., and Frederick B. Power, Ph. D. Philadelphia: Henry C. Lea's Son & Co. 1883. Pp. 624.

Compendium of the Tenth Census. Part I, pp. 923; Part II, pp. 847. Washington: Government Printing-Office. 1883.

Annual Report of the Chief Signal-Officer for the Year 1880. Washington: Government Printing-Office. 1881. Pp. 1,120, with 119 Maps and Charts.

The New Cyclopædia of Family Medicine: Our Home Physician. By George M. Beard, A. M., M. D. New York: E. B. Treat. 1881. Pp. 1,506. Illustrated. $7.50.

First Annual Report of the Bureau of Ethnology. 1879–'80. By J. W. Powell, Director. Washington: Government Printing-Office. 1881. Pp. 603. Illustrated.

POPULAR MISCELLANY.

Fossil Man in America.—The question of the contemporaneity of man with the horse and other pliocene mammals was recently brought up, in the Academy of Natural Sciences of Philadelphia, in the presentation of some fossil remains of horses by Professor Leidy. Professor Cope said that he believed that the contemporaneity would soon be satisfactorily established, and brought forward the Calaveras skull, which was said to have been taken from the gold-bearing gravel of California, and two observations of his own, made in 1879 in Oregon and California, as further confirmatory of the point. The "Carson foot-prints" of Nevada could also be placed in evidence, for they probably belonged to an ancestor of existing man. Professor H. Carvill Lewis insisted that caution should be exercised in accepting as evidence of pliocene man any facts as yet not verified by scientific observers. While the facts proving a post-glacial man were indisputable, the existence of pre-glacial man, either in our own country or in Europe, was not attested by any scientific evidence. The discoveries in California, made for the most part by miners in search of gold, carried with them several serious objections to the theory of great antiquity. The implements were identical in character with those of modern workmanship, and the Calaveras skull closely resembled that of a modern Indian. The fact is not generally mentioned that implements in all respects similar to those of the auriferous gravel occur upon the surface of the ground, and are believed to be the work of well-known tribes. Neither the Calaveras skull nor the implements have suffered the amount of corrosion or weathering that a great antiquity should have given them. The adherence of compact gravel to the Calaveras skull, which is regarded as a sign of great antiquity, is no evidence at all of it, for the same is seen in the case of modern coins and other objects of known date. The very fact that the relics under consideration all occur in a gold-bearing gravel may indicate the method by which many of them were buried. Gold-mining was carried on, on quite an extensive scale, by the aborigines in these same gravels. Schoolcraft describes an ancient shaft in Table Mountain two hundred and ten feet deep, at the bottom of which human bones and implements were found. The argument from analogy is so strong against the great antiquity of the California relics, that evidence of the most satisfactory kind must be required to support such a conclusion.

Dr. George M. Beard.—The late Dr. George M. Beard, whose articles in the Monthly will be remembered by many of our readers, was a graduate of Yale College, began his medical studies in the same institution, and, after an experience of eighteen months as acting assistant surgeon in the United States Navy, received the degree of M. D. at the expiration of a two years' course in the College of Physicians and Surgeons of this city. Beginning practice in New York, he early turned his attention to the study of nervous diseases, and almost immediately began to write and publish on medical subjects. Among his earlier works "Our Home Physician," 1869, "Eating and Drinking," and "Stimulants and Narcotics," 1871, were designed for popular use, and have, we understand, had a wide circulation. In conjunction with Dr. A. D. Rockwell he published, in 1875, "Medical and Surgical Electricity." "Hay-Fever, or Summer Catarrh" appeared in 1876; "The Scientific Bases of Delusions," 1877; "Nervous Exhaustion," 1880; "American Nervousness, with its Causes and Consequences," 1881.

These are among his more important contributions to medical science, and, with a large number of pamphlets and magazine articles on allied subjects, make up a volume of literary work it is rarely accorded to one man to accomplish. And when we reflect that behind much of it there lies a large amount of observation and experiment on which many of his views are founded, it becomes apparent that Dr. Beard's was an exceptionally busy as well as useful life. Yet, enthusiastic and indefatigable as he was in his chosen field, it must be confessed that the quantity of his work was too often at the expense of the quality. His conclusions were not always as thoroughly matured and as accurately verified as the interests of science demand; or, as a personal friend has said of him, while he had wonderful insight as an investigator, "his defects were too rapid generalization and too positive and comprehensive assertion of results. . . . His fame would be more enduring if he had written five books instead of fifty." Although his work is liable to these criticisms, he undoubtedly did a valuable service in calling attention to and throwing light upon a class of nervo-mental affections which, though very common and the cause of much suffering, are not yet well understood. In their further study the future investigator will find much to aid him in the writings of Dr. Beard, and, as the difficulties of the subject are more clearly realized, the work that he has done will be better appreciated.

Treatment of Stammering.—Mr. J. E. Suitterlin has for eight years conducted an institute in this city for the cure of stuttering and stammering, with most satisfactory success. His system is philosophical and simple, and is based on the plainest common-sense principles. Excluding reliance on medical aids, it comprises chiefly careful drill of the vocal organs, and such mental discipline as will contribute to the object. In the first stage of treatment, the subject is not permitted to talk, except to practice his exercises, and to make such movements in speech as can be guided and observed by the teacher. During this time he is taught to consider himself, not a patient, but a student of speech. In the second stage, which is begun when enough has been done in the first, the pupil is encouraged to talk, for practice, at every opportunity, with a "legato" movement (as in music) and a strong accent. In the third stage he is allowed to talk more naturally, but in a studied manner; and in the fourth stage he is permitted to employ his normal way of speaking, but is by this time relieved from the impediment under which he formerly suffered. The psychic part of the treatment, which aims to divert the pupil's mind from himself and his troubles, is the most difficult and, at the same time, the most essential part. The time required for success depends very largely and, in fact, chiefly on the mental constitution of the subject.

From this brief description of an effective method of treatment, the parent may gather the useful hint that, to remedy any incipient tendency in his child to stammer, he should exercise a mild and kind but firm ruling, suppress all irritability of temper, observe for the child all the laws of health, and be careful as to his own manner of talking and the patterns he may set for the child. By attention to such matters, even the most unskilled may correct the evil before the child begins to be conscious that he is a stammerer; and, by a general regard to such principles as are here laid down, the affliction might be wholly removed or its frequency greatly reduced in the course of a generation or two. The statistics collected and preserved by Mr. Suitterlin show that the stammering habit is contracted, with only very rare exceptions, between infancy and ten years of age.

The First Daguerrean Portrait.—Professor Charles E. West, who was a personal witness of the event, has contributed to the "New York Times" an interesting account of the introduction of the daguerreotype process into the United States, and of the taking of the first portrait by Professor John W. Draper, and not by Mr. A. S. Wolcott, for whom the honor has been claimed. The secret of the process having been bought and published by the French Government, a pamphlet describing it was brought to New York by a Mr. Seger. Professor Morse, to whom the pamphlet was given, employed Mr. George W. Prosch to make an instrument after the description in it. The first

picture taken with this instrument—the first daguerreotype of still-life taken in this country—was a view of the old Brick Church and the City Hall in New York, and was a great curiosity. Daguerre's process required an exposure of twenty minutes, and he said that living objects could not be taken by it, on account of the difficulty of their keeping still so long. Professor Draper succeeded in shortening the exposure by substituting bromide of iodine for the iodine used by Daguerre, and with the aid of this compound took the first portrait of the human face. This was in 1839, and the success of the experiment was announced in a note dated March 31, 1840, in the London "Philosophical Magazine" for June, 1840. Professor Morse afterward tried the process, and took a portrait of his daughter. Mr. Prosch opened a daguerrean gallery at the corner of Broadway and Liberty Street, where Professor West was the first to sit for his portrait. The light of the sun was thrown directly upon his face by reflection from a mirror; consequently, he had to shut his eyes, and they were represented closed. Mr. Wolcott was not ready to begin his work till the spring of 1840; but he was successful in taking the best portraits in the city. The question of priority was not raised till 1860, when it was considered by a committee of the American Institute, to whom Professor Draper submitted a written statement, while the friends of Wolcott failed to do so. Draper is also credited in the "Edinburgh Review" for January, 1843, with having been the first person who took portraits by the daguerreotype process.

The Prevention of Insanity.—Dr. Nathan Allen, of Lowell, Massachusetts, in a pamphlet on that subject, calls attention to the prevention of insanity as a question which, although much neglected, is at least quite as important as that of the cure of insanity. The disease is very largely dependent on physical and sanitary conditions, and these should be studied out and brought within such regulation as will prevent its development. Since, according to the late Sir James Coxe, insanity originates in some form of disease or in a deterioration of the body rather than in an exclusive affection of the nervous system, its growth should be checked by a general diffusion of the knowledge of the laws of the human organism and the use of all means necessary for the preservation of good health. So far as insanity is hereditary, its transmission should be prevented by avoiding marriage with persons predisposed to it. It should be the aim of the medical profession to become so well acquainted with the diseases of the nervous system and the brain that they could detect the first symptoms of disturbed or deranged states of mind, so as to be able to treat them understandingly, and, in all probability, in many cases successfully.

The New York State Museum of Natural History.—The Trustees of the New York State Museum of Natural History, having about eight thousand square feet of space available for the exhibition of specimens requiring twenty-one thousand square feet for their proper display, complain that the present museum-building has become entirely inadequate for its intended purpose. Relief is anticipated, however, from the gradual occupation of the State Hall, a fireproof building, which is authorized as fast as its rooms may become vacant by the removal of State offices to the new Capitol. A consolidation of the scientific work done under the patronage of the State, which is now scattered under several distinct heads, is recommended by the trustees, so as to make it all a part of the museum. The reports of the museum, and the scientific work generally, now lagging far behind, under the operation of the political patronage and plunder system of printing, are impatiently waited for by the scientific world, and the trustees suggest that the demand could be more speedily and fully satisfied if the printing of them were intrusted directly to the institution. Four volumes of valuable museum reports are still unprinted, though long due. Of the Geological Survey's work on Paleontology, five parts have been published in seven bound volumes. Five bound volumes are required to complete the work, for which a considerable proportion of the plates and manuscript are prepared. Seventeen letters and declarations, from as many eminent scientific men and societies, are published, in connection with the statement of the trustees of the

museum, attesting the anxiety with which they are looking for the completion of this, one of the most important and meritorious works of the kind ever attempted.

The Solar Eclipse of May, 1883.—M. Janssen announced in the French Academy of Sciences, on the 26th of February, that the French Scientific Expedition to observe the total eclipse of the sun in May would start on the 6th of March, to meet at Panama a French naval vessel which would take it to Caroline Island, a hundred leagues north of Tahiti. After the observation is completed, the expedition will proceed to Tahiti and San Francisco, whence M. Janssen proposes to visit the observatories and scientific establishments of the United States. Search for intra-Mercurial planets will be made for the first time by the aid of photography. A grand photographic apparatus has been prepared to take in the whole field surrounding the sun for about thirty degrees, which will furnish images, if the sky is clear, of all the stars to the eighth magnitude. Gelatine plates of extreme sensibility will be employed. Other instruments are provided for photographing the corona and its spectrum, for examining the spectrum of the corona, and for the exploration of the solar regions. Several foreign astronomers will be attached to the expedition at their own request, and the American and English expeditions will co-operate with it at the same place; so that the ordinarily uninhabited Island of Caroline will become, for the hour, the scientific center of the world. It will enjoy this distinction chiefly because it and Flint Island, not very far off, are the spots most favorable for the observation of the eclipse. This eclipse is expected to offer unusual facilities for observation, on account of the long duration of totality ($5^m\cdot 33^s\cdot$ at Flint Island, $5^m\cdot 13^s\cdot$ at Caroline Island).

What shall we do with our Drunkards?—Dr. Orpheus Everts, Superintendent of the Cincinnati Sanitarium, in an inquiry on "What shall we do with the drunkard?" regards drunkenness as a disease. The only ways of dealing with it effectually are by prohibition of the sale of intoxicating liquors and inhibition or restriction of the drunkard. The former measure he dismisses as essentially impracticable, on account of the antagonism it must always excite; and he is left only the latter one, which he would have surrounded with the sanctions of the law. He proposes a scheme of a law for the establishment of Public Hospitals for the Cure of Drunkenness and Conservatories for the Protection of the Infirm, to which persons defined by it as coming under its import may be formally and legally committed for cure or care. When thus committed, they should be allowed every liberty or natural right which can be conserved without lessening the efficiency of the law, and should be protected, under the sanction of stringent penalties, against assaults upon their weakness, or temptations from any source.

Niagara Falls as a State Park.—The movement for the rescue and preservation of Niagara Falls is gathering strength, and is now seeking legislative action, authorizing the appointment of a commission to examine the question and estimate the cost of carrying out the project as an enterprise of the State of New York. It is a real disgrace to our people that this, the most wonderful object of the kind on the earth, the first feature of our natural scenery which strangers from all climes hasten to see, and which ought of right to belong to mankind, should have been left in the hands of speculators till it has been shorn of many of its natural beauties, and it can not be seen at all from our territory except on the payment of a showman's fee. By reason of these facts, and the endless extortions characteristic of the place, what used to be one of the favorite pleasure-grounds of the continent is now visited for a few hours only, as a kind of side-show, and that largely by excursions in the lump. The plan for the State's acquisition of the territory, as approved by the State Survey, contemplates the purchase of really only a small area, generally of about a hundred feet in width, extending from the head of the rapids to the upper suspension-bridge, and of the islands. Then by suitable plantations and the provision of water-breaks the ground is to be restored as nearly as possible to its natural condition and kept so. With these improvements, and the relief from extortion that will accompany State

ownership, visitors will be attracted in greater numbers than ever before, as the facilities of access are improved, and what now offends their eyes is removed. The present condition of the falls and the character of their visitors, the imminent danger they are in of being robbed of all that makes them attractive, and the facts that make the question of their immediate rescue a pressing one, are forcibly presented by Mr. J. B. Harrison, Corresponding Secretary of the Niagara Falls Association, Franklin Falls, New Hampshire, in a pamphlet "On the Condition of Niagara Falls and the Means needed to preserve them." California has reserved the Yosemite Valley and the Big-Tree Grounds, and the United States the Yellowstone Lake and Geysers, as public parks. It should be the duty of the State of New York to add to the list its stupendous cataract.

Dyspepsia.—The late Dr. Leared, in his recently published essay on "The Causes and Treatment of Indigestion," lays down as a fundamental principle that the amount of food which each man is capable of digesting with ease always has a limit which bears relation to his age, constitution, health, and habits, and that indigestion is a consequence of exceeding this limit. Different kinds of food are also differently adapted to different constitutions. Dyspepsia may be brought on by eating irregularly, by allowing too long an interval between meals, and by eating too often. Frequently the meals are not gauged as to their relative amount, or distributed with a due regard to health. Thus, when we go out after taking a light breakfast and keep at our work, with a still lighter lunch only during the interval, till evening, we are apt, with the solid meal which tempts us to indulgence, to put the stomach to a harder test than it can bear. "When a light breakfast is eaten, a solid meal is requisite in the middle of the day. When the organs are left too long unemployed they secrete an excess of mucus which greatly interferes with digestion. One meal has a direct influence on the next; and a poor breakfast leaves the stomach over-active for dinner. . . . The point to bear in mind is, that not to eat a sufficiency at one meal makes you too hungry for the next; and that, when you are too hungry, you are apt to overload the stomach, and give the gastric juices more to do than they have the power to perform." Persons who eat one meal too quickly on another must likewise expect the stomach finally to give notice that it is imposed upon. Other provocatives of dyspepsia are imperfect mastication, smoking, and snuff-taking, which occasion a waste of saliva—although some people find that smoking assists digestion, if done in moderation—sitting in positions that cramp the stomach, and the pressure that is inflicted on the stomach by the tools of some trades, as of curriers, shoe-makers, and weavers. The general symptoms of dyspepsia are well known. Some that deserve special remark are fancies that the limbs or the hands are distorted, mental depression, extreme nervousness, hypochondria, and other affections of the mind. The cure is to be sought in avoiding the food and habits by which dyspepsia is promoted, and using and practicing those which are found to agree best with the system of the subject. Regularity in the hours of meals can not be too strongly insisted on. "The stomach should not be disappointed when it expects to be replenished. If disappointed, even a diminished amount of food will be taken without appetite, which causes the secretions to injure the stomach, or else impairs its muscular action."

Scotch Funerals in the Olden Time.—Mr. William McQueen, in "Macmillan's Magazine," gives a somewhat amusing description of the Scotch funeral customs of the olden time. The usages varied in details in different parts of the country, but were marked as a whole by a general similarity. In some places every man who heard of a death made it a point to attend the funeral; if a Sunday intervened, the time of the funeral was intimated in the church-yard between the services. In other places messengers were sent around to give information of the death—not to invite friends to attend, for that was regarded as a matter of course; but in Glen Urquhart the next-door neighbor of the deceased would not go to a funeral without receiving a direct invitation. The custom of supplying drink at the funeral was once uni-

versal, but it was found expedient in some places to postpone the treat till the corpse had been safely taken care of. At Bridgton, a glass of wine was given to each mourner, and a biscuit, on the top of which was placed a piece of dark-colored orange-peel. It is just possible that the presence of this ornament "was the perpetuation of a symbol used at old heathen rites. Quite within living memory it was also customary to put a black mark on some of the oat-cakes served along with whisky in public-houses in Ruthergien, near Glasgow. Few, if any, of those who observed this custom in baking the cakes latterly could have the least notion of what their action implied; but its origin may be traced to the old heathen practice at the feasts of Baal, of giving bread with a black mark upon it to those unhappy persons who were selected as victims to be sacrificed." No religious service was held at the grave; only the hats of the attendants were taken off sometimes for a moment when the coffin was lowered. The omission "had its origin, no doubt, in the Scotch horror of doing anything that might give a color to the charge of following the Roman Catholic fashion of praying for the dead." Sometimes a chapter in the Bible was read and a short prayer pronounced in the house before the procession set out for the churchyard; but care was generally taken in these preliminaries to disconnect them from the peculiar circumstances of the occasion. Thus, at one funeral, refreshments were served, and the offering of the prayers was so arranged as to give them the appearance of being a grace before and a grace after meat. The starting of the funeral procession was colloquially called "lifting," in allusion to the "lifting" of the coffin or the taking of it up to carry it from the trestles on which it rested, with "spokes" or bearing-poles. Efforts to do away with funeral treats, which were justly prompted by the scandals to which the drinking gave rise, were strongly and bitterly opposed. One man, who had become an abstainer, gave great offense by providing milk instead of liquor. His neighbors ascribed his conduct to meanness, and had nothing but scorn for his plea of principle. "Principle had nothing, and could have nothing, to do with it," they asserted. "The minister had no scruple in taking off his dram, and was he going to set himself up as better than the minister?"

Burmese Animal Life.—The "British Burmah Gazetteer" gives some notes of rare interest on the zoölogy of the country to which it relates. The mammalia include the Malasian tapir, four species of rhinoceros, a fresh-water dolphin, and bats. Most of the bats hibernate, as their congeners do in Europe, and one is remarked for the reservoir of fat which it accumulates in its tail, to serve it in winter. The list of birds runs up to seven hundred and seventy-three species, or a hundred more than there are in all Europe. A curious fact is that several species are found in the Island of Java, eight hundred miles south, while they are wholly wanting in the neighboring peninsula of Malacca. Species that are found in India only at the foot of the Himalayas, at a considerable elevation, occur here at the level of the sea. Species of birds identical with those of Europe, or similar to them, are not rare. The variety of the fauna is explained by the physical configuration of the region, where a walk of a few hours will carry one from the green sod of meadows intersected by rice-fields to the inaccessible precipices of the granitic mountains, from the sea-shore jungles of bamboo and the rich, tropical vegetation of the coasts to immense virgin forests and the stiff and dark pines of the mountain-sides. The list of reptiles is discouraging to the settler, for it furnishes four crocodiles and seventy serpents, one of which is a python thirty feet long, and the bite of fifteen is poisonous. The list of fishes is the most interesting of all. It includes the *Anabas scandens*, which they say comes out of the water and goes up into the trees for insects; species that have a reservoir of air above the gills, and will die of asphyxia if they are kept under water and prevented from drawing air directly from the atmosphere; a siluroid that has an accessory respiratory apparatus attached to the branchiæ; and the fish-scorpion, which has a long air-vessel passing across the muscles of the back, and communicating interiorly with the gills: this explains how these fish can live in mud. These respiratory organs seem close-

ly adapted to the estivation which is the forced consequence of the pluvial *régime* of the country. After a heavy shower numerous fish will make their appearance in places that were absolutely dry a few hours before. Living fishes of certain species may be found buried two feet below the dry surface of the soil. The *Ophiocephalidæ*, like our eels, pass from one pond to another by gliding through the moist grass, and the *Amphipnous cuchia* loves to rest on the ground hidden in high grass; and one may see it leap into the water when he approaches it. The *Ophiocephalus striatus* builds a nest with its tail among the aquatic plants on the banks of the rivers, and finishes it off with blades of grass, which it cuts with its mouth. The eggs are laid in the nest, and the male takes care of them, or, if he dies or is captured, the female takes his place. Both watch the fry with as much care as a hen takes of her chickens, but will drive them away when they have become large enough, and will eat them up if they do not go. The male of the *Arius burmanicus* hatches out its little ones in its mouth; fifteen or twenty eggs in different stages of development, and even recently hatched young ones, may be found in the buccal cavity and on the branchiæ; and, during the whole period of this incubation, the fish takes no food. The varieties of the fauna of this country support the hypothesis that it was primitively an archipelago, separated by arms of the sea. The forms are often totally different on mountains, having precisely the same geological formation, only fifteen or twenty miles apart.

A Premature Burial.—M. G. Eric Mackay presented, in "The Popular Science Monthly" for January, 1880, a number of apparently authentic instances of cases in which premature burial had occurred. In a subsequent number of the "Monthly" (August, 1880), Dr. William Lee depreciated the danger, and undertook to show that premature burials were extremely rare. An instance very similar to some of those recorded by Mr. Mackay, and showing that the danger is an actual one, is related in the "Viedomosti" of Samara, Russia. A clerk while drunk was seized with an epileptic fit, and apparently died. As the next two days would be holidays, when burials would not be permitted, it was decided to lay him in the ground that very night. Drops of sweat were seen on his face during the funeral services, but no attention was paid to the matter because it was thought the drops might have come from snow that fell on his face on the way to the church. But little earth was thrown on the coffin, on account of the lateness of the hour. When the grave-digger went the next morning to fill up the grave, he heard a noise, as of groaning and struggling in it. Instead of releasing the man, the sexton went to the priest to ask permission to do so. The priest sent him to the police; the police sent him and the man's wife, who had joined him, to the chief; the chief sent them to the archimandrite, and he to the procurator. At last a permit was obtained, after five hours, but then the man was dead, having left in the coffin evidences of a hard struggle. He had turned around, bitten his fingers, torn his flesh, and rent his clothing. It is hard, in reading this story, to decide whether most to admire the stupidity of the grave-digger and the victim's wife, or the elaborate complication of Russian red-tape.

Improvements in Insurance Management.—The "Pall Mall Gazette" notices signs of improvement and invigoration in the management of the English life-assurance companies during the past year, particularly in the matters of the settlement of claims immediately after death, liberal extensions of the limits of residence, facilities for the renewal of lapsed policies, the introduction of the paid-up policy system, and the simplification of the initiatory stages in paid-up policies. Tendencies are observed, too, toward the reduction of rates to a simple living basis, and the gradual working out of the "bonus" system. The companies are still, however, obliged to meet the sharp competition of American enterprises, which are able to offer inducements enhanced by the higher interest on their investments; but they ought to be able to neutralize these advantages, it is suggested, by those which they enjoy from the prestige of their long career and honorable position, and from the less cost at which their business is conducted.

NOTES.

THE first attempt to manufacture incandescent electric lamps *in vacuo* has been ascribed to M. de Chagny, whose effort was made about twenty years ago. Mr. W. Mattieu Williams claims the credit of the invention and its successful practical application for a young American, Mr. Starr, whose patent was taken out in 1845. Mr. Williams had a share in the venture, assisted in making the apparatus and some of the experiments, came into possession of the invention by assignment on the death of Mr. Starr, and exhibited the light in the original lamp, at Birmingham, several times, more than twenty years ago. An account of the lamp is given in the "Journal of Science" of November 5, 1879, and is reprinted in Mr. Williams's "Science in Short Chapters."

THE Smithsonian Institution has received from Dr. Stejneger, from Behring Island, eleven fairly perfect crania of the extinct *Rhytina Stelleri*, a mammal allied to the dugong and manatee, with sets of nearly all the other bones of the skeleton.

THE additions to the herbarium of the Academy of Natural Sciences, of Philadelphia, during the past year, exceed those of any year since the organization of the Botanical Section. They are estimated at 3,346 species, of which more than one third were new to the collection, and include more than one hundred genera not before represented in it.

THE composition of elephant's milk, according to the analysis of Dr. Quesneville, in the "Moniteur Scientifique," is similar to that of cream, but its consistency is different. Its odor and taste are very agreeable, and the taste is superior to that of most other kinds of milk. It is about equal to cow's milk in quality. In view of these facts, "La Nature," of Paris, does not despair of seeing the day when an adventurous speculator shall bring a troop of elephants to be driven through the streets of the city as goats are now driven, to furnish each customer with his cup of milk direct from the teat.

M. DE MEREJKOWSKI has been investigating the color-sense of the crustacea, taking for his experiments the larvæ of cirripeds and a cepepod. In the dark these animals scatter everywhere in the vessel containing them; if a ray of light is admitted, they collect around it, whatever its color; if two rays, one white and the other colored, are let in, the majority congregate around the white ray, but a few go to a colored one; if two colored rays are admitted, the majority seek the brightest, but, if both rays are of equal intensity, no difference in choice is perceived.

AN International Electric Exhibition will be held at Vienna, in the Rotunda and buildings of the Universal Exhibition of 1873, from the 1st of August to the 31st of October next. Goods will be received from the 1st of June, and all exhibits must be unpacked and set up by the 15th of July. The Society of Telegraph Engineers and Electricians, which numbers Sir William Thomson, and Messrs. Siemens, Preece, and other distinguished experts among its members, will manage the English departments of the exhibition. The proceeds of the enterprise are to be devoted either to such scientific institutions as may further carry out its aims, or to the pursuit of important inventions in the field of electrical science.

THE French *Société d'Encouragement* has conferred the grand medal of the Economic Arts on M. Gaston Plante, for his experiments and discoveries with storage-batteries.

THE Royal Swedish Geographical Society has decided to appoint a committee, consisting of Professors Nordenskjöld and Gyldén, and Consul Elfning, to consider the proposal for an international meridian and a common time.

THE experiments in acclimating the tea-plant in Southern France are making encouraging progress. Grafts upon camellias have withstood temperatures below the freezing-point in the open air. A hundred and twenty trees near Messina, Sicily, planted three years ago, are vigorous and in full leaf and flower. The question now to be decided is, whether the flavor is maintained undamaged.

THE Veterinary and Agricultural Society, at Chartres, France, has just published the results of a year's experiments in vaccination for anthrax according to M. Pasteur's system. The number of sheep vaccinated was 79,392, in flocks among which the total average loss per year for ten years had been 7,237, or 9·01 per cent. The deaths from anthrax after vaccination were only 518, or 0·65 per cent. The disease did not rage, however, as fatally among the unvaccinated flocks as usual, and the rate of loss among them was reduced to 3 per cent. The total loss, if there had been no vaccination, might not have been more than 2,382. Vaccination reduced this by nearly four fifths. In mixed flocks, the losses among vaccinated animals were 0·4 per cent; among unvaccinated ones, 3·9 per cent.

M. VIGNIER believes that animals are indebted for the powers of direction which they sometimes manifest so strikingly to the possession of a magnetic sense relating to the forces that govern both the direction and the inclination of the needle, the seat of which he locates in the semicircular canals of the internal ear.

BENJAMIN SILLIMAN, LL. D.